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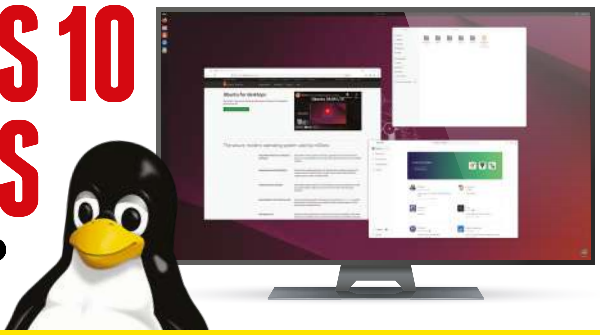

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8 Linux distros to keep PCs alive

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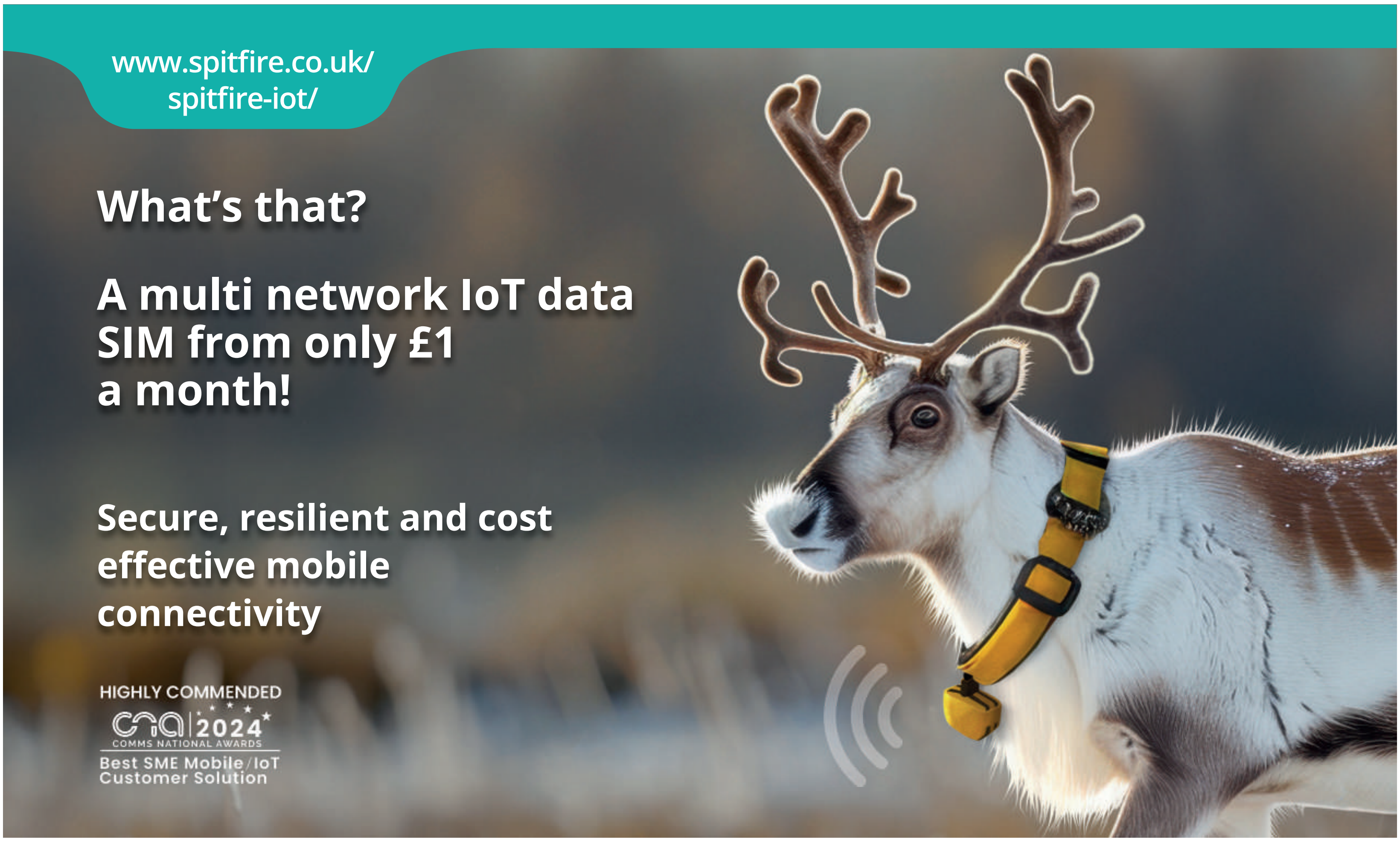
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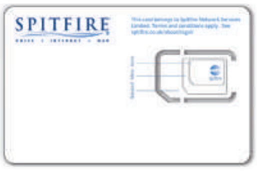

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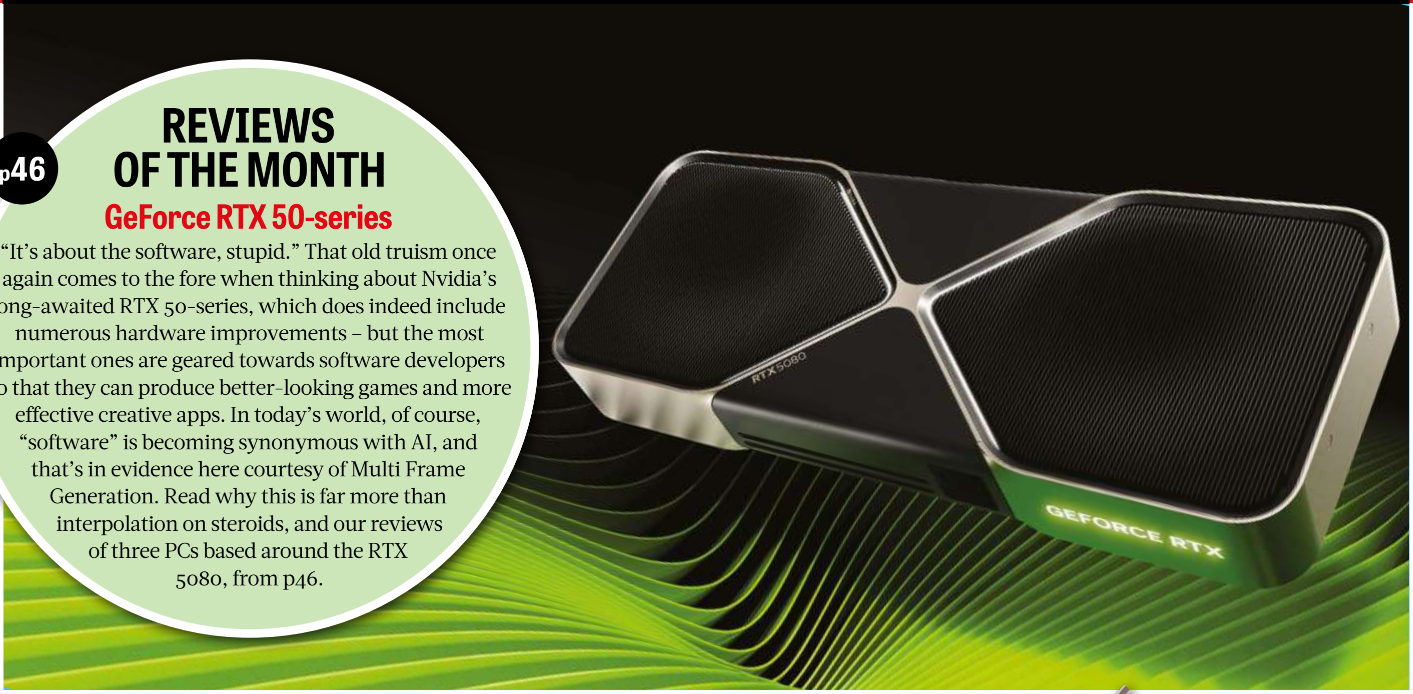

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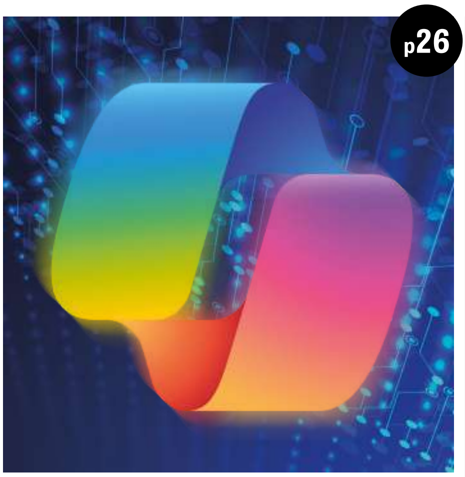
REVIEWS OF THE MONTH

GeForce RTX 50-series

"It's about the software, stupid." That old truism once again comes to the fore when thinking about Nvidia's long-awaited RTX 50-series, which does indeed include numerous hardware improvements – but the most important ones are geared towards software developers so that they can produce better-looking games and more effective creative apps. In today's world, of course, "software" is becoming synonymous with AI, and that's in evidence here courtesy of Multi Frame Generation. Read why this is far more than interpolation on steroids, and our reviews of three PCs based around the RTX 5080, from p46.



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INEVITABLE AI FEATURE OF THE MONTH

Microsoft has just pushed up the annual price of its Microsoft 365 Family subscription by £40 to pay for all its AI-enhanced features – we find out if they're worth the price.

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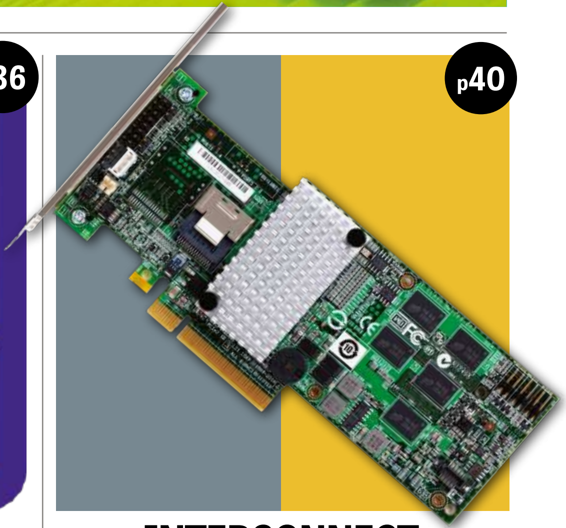
Bucking the trend of subscription software, you can buy Affinity Photo on its own for £68 (or the whole suite for £160). Here, we show you how to make the most of that investment.



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PCI Express is the interconnect technology that ties modern computers together, and we're currently seeing a shift from PCIe 4 to PCIe 5. We reveal the secrets behind its 20+ years of success.

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Trevor Linney

Could Britain be on the cusp of 50Gbits/sec broadband? We interview Openreach's director of network technology to discover how its latest trials have gone and what the future holds.

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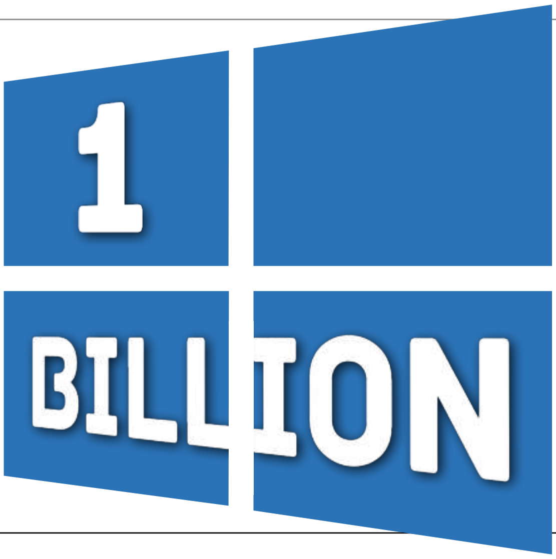
That's roughly how many PCs are still running Windows 10, which goes end of life this year. Linux is a superb choice to replace it, but which distro should you choose? Our Labs reveals all.



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A new Outlook has dawned and it's bringing some of us to tears

I'm not having much luck with computers at the moment. Within the space of a month, two died on me: one long-serving laptop that I still have hopes of resuscitating through a reset, the other an emergency machine that, without warning, obstinately refused to switch on. So, in my desperation, I hauled the Nvidia RTX 5080-powered Scan 3XS Edge iCue (*see p50*) onto my desk to provide daily service until today – the day we send *PC Pro* to the printers.

So what astonishing lessons have I learned from this series of events? What words of wisdom can I impart that will shake to the foundations all that you hold true? This: the new version of Outlook is rubbish.

Until a week ago, I hadn't realised how much I relied on Outlook. It was part of my daily grind, a boringly predictable way to manage my emails. Sure, it was both ugly and functionally almost identical to Outlook circa 1976 – I'm 99% sure that's when it came out – but it did the job.

The new Outlook isn't that new, having been released to personal users in September 2023, but until recently you could always find Outlook "Classic" hiding away (or on the Microsoft Store). My pattern of behaviour for months was to try the new version out of a sense of duty, cry a little, and then revert back to the old one. And this is why, Microsoft: the new Outlook is all that is wrong in the world squeezed into one application.

Let's start with adverts. I pay for Outlook as part of a Microsoft 365 subscription, one that will now cost me £120 per year – although we cover how to avoid this in our feature starting on p26. The crucial three words there are "I pay for". This is not a free product. Microsoft, in case you haven't got the message, I give you money. So why in this already blighted world have you decided to insert adverts at the top of my inbox?

No, come on Microsoft, don't hide away: why?

We all know the reason: money. Greed. A company that last year made $88 billion in profit wants to squeeze a few micro-cents out of me every time I open my inbox. "A company has a responsibility to make a profit for its shareholders," I hear you cry, and of course, yes, it does. But I bet that many of those shareholders use Outlook. If they've clicked on those ads accidentally, as I have, I'm certain they hate them too.

I also despise the interface. Surely Microsoft has UI and UX experts to tell it that people sort their email using the tabs at the top of the panes? Surely those experts raised objections when developers inserted tickboxes next to emails that serve no purpose other than to irritate? And why is there a ribbon down the left-hand side offering me a chance to open Word, Excel and PowerPoint, which all have precisely nothing to do with messaging?

I can only assume that it's because Microsoft, like all American mega companies, lives in its campus bubble where such decisions make sense. This is why it has thrown out genuinely useful features such as email aliases, which millions of micro businesses – including my own – rely upon to add professionalism to their correspondence.

But my biggest question is this. Why, after investing tens of billions of dollars into AI, can't Microsoft inject faintly useful intelligence into the email application that so many of us rely on every day? That's an answer even Copilot can't figure out.

Tim Danton
Editor-in-chief

CONTRIBUTORS

Barry Collins
Always willing to delegate dull tasks to others, Barry investigates exactly how good Copilot is in Word, Excel, PowerPoint and Tim's best friend Outlook from **p26**.

Nik Rawlinson
With Windows 10 going end of life this year, and many PCs incompatible with Windows 11, we asked Nik to test and rate the best Linux distros. Read his verdict from **p78**.

Lee Grant
It's all very well having replaceable parts for PCs and printers, explains Lee, but the system fails if you can't buy them – or, worse, if they're incompatible when they arrive. See **p113**.

Olivia Whitcroft
Aside from sampling many excellent red wines, Olivia learned much from an ill-fated trip to Paris when it comes to governing law. Join her for a tipple on **p116**.

April 2025 Issue 367

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If your computer featured the best graphics card in the world, what would you use it for?

"The one genre of game I really enjoy is motor racing, and so I would use it to create the most realistic racing experience I could. I don't think we'll have to wait too long for photo-realistic tracks in real-time, taking simulations to an even higher level."

"eBay. The two-year-old phone in my pocket is more than powerful enough for any game I'm interested in. Probably by several orders of magnitude."

"Heating my office, which is bloody freezing at the moment."

"Given I have no real use for such performance, I'd probably sell it and go to Paris."

"My computer is a bit old as it's second-hand (as I want to be green) and uses integrated graphics, so short of fashioning my own PCIe slot I would have to donate it..."

"Driving my unspeakably ancient IBM (not Lenovo!) T210 early TFT display. Inferior adapters can't understand its resolution options."

"I'd use it for family entertainment by flogging it on Back Market and taking the kids to the seaside on the proceeds. You can get a lot of donkey rides for an RTX 5090."

"I would build 3D models of historic places – think recreations of Rome in the Roman era, or London in the 1300s. And then explore them using the Apple Vision Pro."

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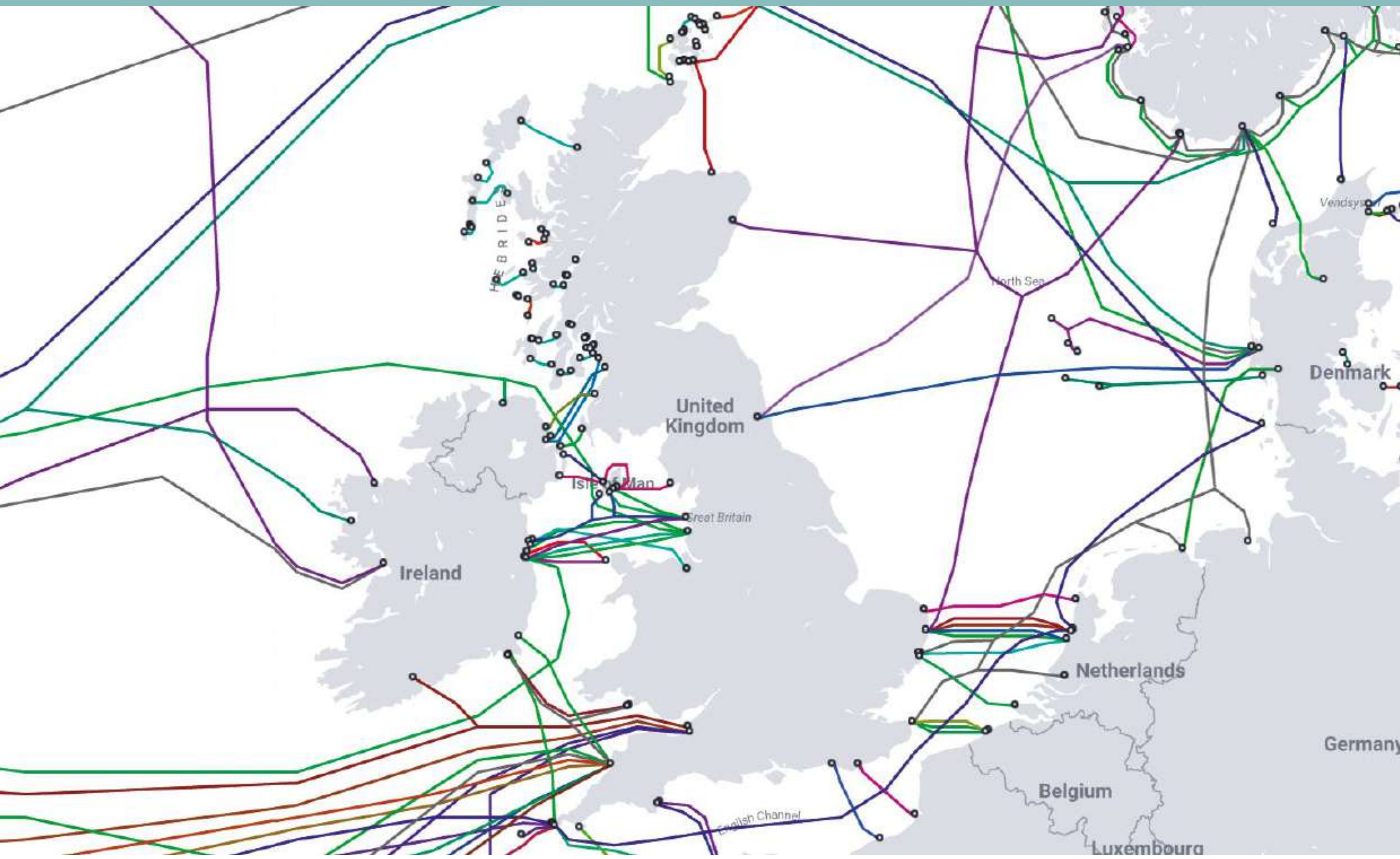


ABOVE **Around 70 undersea cables connect the UK with the rest of the world**

Image: TeleGeography

The growing threat of the cable cutters

Experts warn of increasing threat to the subsea cables that connect UK to the rest of the world

If you've ever lost your broadband connection because a local construction project sliced through the cables, you'll know the disruption it can cause. Well, magnify that from a local to a national scale and you can understand why the government is prepared to send out navy submarines to ensure the subsea cables connecting the UK to the rest of the world aren't sabotaged.

That's precisely what happened in November last year, when a Royal Navy submarine was ordered to surface close to a Russian spy ship called the Yantar, which was believed to be mapping the UK's critical undersea infrastructure. Two months later in late January, it was spotted again, and this time HMS Somerset and HMS Tyne were deployed to see off the Russian vessel.

The Yantar's second appearance in UK waters came just a month after Russia was accused of sabotaging an undersea electricity cable between Finland and Estonia on Christmas Day, as well as previous attacks on communications in the region, prompting a new NATO operation to protect critical infrastructure in the region.

The January incident raised the alarm among politicians. Just how vulnerable are the UK's undersea cables, they asked? Could the UK even be cut off from the rest of the world? We've spoken with experts to find out just how precarious the UK's links to the rest of the world are.

> “Just how vulnerable are the UK's undersea cables? Could the UK even be cut off from the rest of the world?”

Raising the threat level

January's reappearance of the Yantar in British waters was sufficient to trigger an

urgent statement in the House of Commons from the defence minister. John Healey addressed the Russian president Vladimir Putin directly in his statement, saying "we see you, we know what you are doing, and we will not shy away from robust action to protect this country".

It's the kind of statement you might expect if a warship was found loitering in the North Sea, but such are the stakes involved in protecting subsea internet and energy cables that experts don't believe the response was excessive.

"These types of [cable cutting] events have been happening for some time, not all sinister," said Gerard Parr, professor of telecommunications engineering at the University of East Anglia, who recently gave a keynote speech at techUK's Subsea Cables Summit.

"They happen in many cases because of natural activities: tidal surges, storms, seismic [activity], ships dropping anchor out at sea where they shouldn't.

"Of course, then there are more sinister actors as well," Parr added, citing incidents in Africa, the Far East and the attacks in the Baltics. "It is of increasing concern now.

"It's increasingly important that we do have response protocols and mechanisms in place, primarily because we're living in an increasingly connected world, and these cables are of significant economic value to the UK."

As you can see from the map opposite, printed with permission, there are about 70 cables around the UK coastline, although many of them are concentrated in small areas with common landing points. There's a cluster in the south west, largely providing transatlantic connectivity; there are several crossing the English Channel to connect the UK to rest of Europe; and there are several linking the west coast of the UK with Ireland.

In the Commons, the Labour MP Mark Sewards told the defence minister it was "so important that we protect these deep-sea cables" because "something like 95% of all international data goes through them".

Widespread disruption?

How hard would it be for Russia or another adversary to damage multiple cables and create a communications crisis? Parr thinks it's "highly unlikely" a coordinated attack could cut off the UK, in part because the cables are designed with built-in resilience and backup routing in case they're damaged.

However, he admits there are challenges in protecting such widely dispersed infrastructure. "They are shielded and well buried, and in some cases suspended," said Parr of the subsea cables.

"Monitoring is key – real-time, effective monitoring so that you can avoid false positives. We can't have Sea King helicopters stationed all around the UK with navy divers. It's just too expensive. And it's not just the cables themselves [that need protection]; don't forget the landing stations."

Part of the reason accurate monitoring is critical is because repairing damaged cables isn't akin to sending an Openreach engineer out in a van. It can take many days or even weeks for repair ships to find a damaged cable and repair it, and it's not cheap. "The technologies to repair are getting better... but it is an expensive operation to repair, depending exactly where the split has happened," said Parr.

The cost of cutting

A report on safeguarding subsea cables published last year by the US-based Center for Strategic and International Studies claimed that repairs cost on average $1-$3 million. What's more, there's a heavy reliance on a small fleet of repair ships, many of which are Chinese-owned. "The over-reliance on Chinese repair ships due to limited alternatives in the marketplace is another vulnerability if, during a time of military conflict, the Chinese government prohibits access to its repair ships and subsea cables are left damaged without timely repair," the report stated.

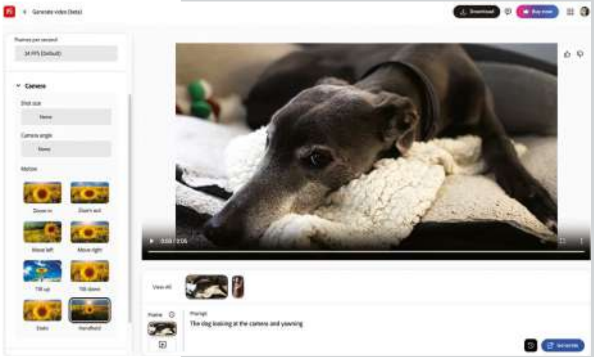
> "It can take many days or even weeks for repair ships to find a damaged cable and repair it, and it's not cheap"

In October 2023, the UK launched its own surveillance ship, RFA Proteus, dedicated to monitoring and protecting critical undersea infrastructure, such as the undersea internet cables. But it can't repair them, a point that leaves UK politicians concerned, especially those representing remote areas.

"This is a strategic threat for the United Kingdom as a whole, but it is particularly acute for our island communities, which rely on cables for digital and energy connectivity, quite apart from the pipelines serving the oil and gas industry," said Alistair Carmichael, the Liberal Democrat MP for Orkney and Shetland, in response to the defence minister's statement about the Yantar. The fact that it's being included in the upcoming strategic defence review shows just how much of a concern it's become.

Adobe's video AI is all filler

Firefly now generates short videos from text or images



Adobe has launched generative video for the first time, both as a standalone product and embedded in Premiere Pro.

Firefly AI can generate Full HD video clips, though they're only five seconds long. While that's not going to launch anyone's Hollywood career, Adobe claims the clips can be used as B-roll or to fill in short gaps in video timelines.

In Premiere Pro, the AI can extend the length of existing clips by a few seconds, in much the same way it can expand the canvas of still images in Photoshop.

"We knew we had created this incredible image model that you've seen, and so we started training it on Adobe Stock videos and some other videos that we sourced," said Adobe's Zeke Koch. "And pretty soon we had something that we thought was really quite cool."

Adobe's revamped Firefly website can generate video clips from nothing but text, or users can upload their own images as a reference frame and have the AI turn that still image into moving video, with text directions on what you want the video to show. You can even upload two still frames – a beginning and an end – and have the AI generate the video in the middle.

Among the other video tools added to the arsenal is the ability to generate clips from 3D models and the option to translate speech in video or audio clips into 20 other languages.

However, Adobe isn't handing this out for free, even to Creative Cloud members who may be paying upwards of £50 per month already. Firefly Standard, which can generate up to 20 five-second clips or translate up to six minutes of audio/video, will cost £9.98 extra per month. Adobe Firefly Pro, which bumps you up to 70 videos or 23 minutes of translation, costs a punchy £29 per month on top of whatever you're already paying Adobe.

The Interview

The road to 50Gbits/sec broadband

Trevor Linney, Openreach

Openreach's director of network technology reveals Britain's broadband future

The UK is now well acquainted with gigabit broadband – 83% of UK homes are capable of receiving gigabit speeds, according to Ofcom research published at the end of last year. But how much faster can we push our fibre networks? Turns out a whole lot faster, as proven by a recent Openreach trial.

The networking arm of BT conducted a trial in Ipswich with Nokia that saw a home achieve download speeds in excess of 40Gbits/sec and upload speeds of just over 20Gbits/sec.

How long will it be before we can all enjoy such speeds, and what on earth will we do with all the bandwidth anyway? Openreach's director of network technology, Trevor Linney, plots the roadmap for us.

PC Pro: Tell us about the trial you conducted and how close it was to a real-life connection.

Trevor Linney: Today we deploy GPON (*see "Once a PON a time..." opposite*) and we've got millions of customers connected to that. We're deploying combo hardware, for XGS-PON, which we'll come back to later. And then the pre-production, emerging technology is 50-gigabits PON.

We took pre-production hardware from Nokia that's fully compliant with the standards, but it's effectively one of the early units that's used to verify the technology, and we validated that it was working correctly here at Adastral Park, which is our engineering HQ for all of Openreach network technology.

> "Normally, I say the killer app for these things is human impatience"

Then we took it down the road to Portman Road [in Ipswich], which is one of our head-end nodes, and connected it to an existing PON, passive optical network – the piece of fibre from that exchange through to someone's home. So it was a live PON with real customers on it, of which one of them happened to be an Openreach employee, and we connected it into their home. It was almost as close to the real thing as we could possibly get.

LEFT Openreach used pre-production hardware from Nokia in its trials

PC Pro: It must have been hard to find a speed test that could measure 50Gbits/sec throughput. Regular tests only have a dial that goes up to 100Mbits/sec!

Linney: No, it's a very serious point, actually. The way we demonstrated was actually using Spirent and Viavi network test equipment, because that's the only thing that can do those sorts of line speeds.

Then think about actually getting a router and a device that can run a speed test at that speed: it's a Herculean high-spec PC to even have a 10Gbits/sec [Ethernet] port in it, let alone a 100Gbits/sec port. So, yes, it was done using effectively network test equipment.

PC Pro: Obviously, we're some way off seeing these connection speeds, but what kind of applications do you think could be unlocked by that type of bandwidth?

Linney: That's the true crystal ball question! Primarily, it's going to come down to either entertainment, gaming or some other real-time thing, and ultimately immersive VR.

Now, when we talk about a 50Gbits/sec PON, we probably wouldn't offer the 40-odd Gbits/sec to one subscriber, because it [the PON] is being shared with up to 32 other people. So you're probably talking a 10Gbits/sec symmetric service or higher.

In that context, you're talking about things like VR. When you've got an 8K screen one centimetre away from your eyeball you need incredible high

LEFT 50Gbits/sec could be on the way – but you may have to wait some time before it arrives in your home

resolution, and critically you need very high frames per second and very low latency.

I think we'll also see things become more seamless between what used to be on your home network and the cloud. If you were doing everything off your cloud provider [today] rather than your local SSD, you'd start to see delay and latency. As you start seeing your broadband connection becoming as fast as your home network, that unlocks certain types of services, and streaming, and ways of working that weren't available otherwise.

Normally, when I answer these questions, I say the killer app for these things is human impatience. What drives speed today is you've decided to download a movie or play the latest *Call of Duty*, and it's 200GB, and you just want it now.

PC Pro: You mentioned the word symmetric in your previous answer. Is the goal to offer symmetrical speeds for downloads and uploads, unlike today's Openreach connections where upload speeds are only a fraction of the downloads?

Linney: Today, GPON offers 2.4Gbits/sec down and 1.2Gbits/sec up. So it's asymmetric by its very nature. Hence, when you're sharing that capacity between up to 32 customers, which is the maximum we have on the Openreach network, you have to be able to say that if people try and use it at the same time, how do you have an equitable share?

The next generation of technology is called XGS-PON; X for 10Gbits/sec and S for symmetric. So that gives us the ability to offer more symmetrical speeds without having that challenge with the technology.

Then with the 50Gbits/sec technology, the ITU actually standardised three flavours: a 12.5Gbits/sec upstream, a 25Gbits/sec upstream and a 50Gbits/sec upstream. In the trial, we used the 25Gbits/sec… but all of them are available. Basically, which one you use comes down to the service that you want to offer and the cost of the optics. As you can appreciate, putting a 50Gbits/sec capable laser into someone's home is not the cheapest of things to do!

PC Pro: What kind of timeline are we looking at for the rollout of this technology?

Linney: Hand on heart, for your typical residential demand, 50Gbits/sec is probably a decade away. Where we are putting our focus is very much being ready for the 10Gbits/sec step.

Today we deploy what's called combo line cards. When we enable an exchange, we stand up a head end… and each port of that we deploy now supports both GPON and XGS-PON. We're seeding our network with that technology so that when people want to move to the 10Gbits/sec variant, it's then a straightforward upgrade for us to do.

There was a report… showing that the only place on the globe that is even thinking of doing 50Gbits/sec is China. You're going to see all the volume in Europe and the US and others on XGS-PON, and that volume is critical, because that drives the affordability of the unit economics down.

> “There is a finite capacity in it, but you don't need to worry about it”

PC Pro: Finally, it's often said that once fibre is in the ground, we're set for life for bandwidth – that you only need to upgrade the electronics at either end of the fibre. Is that true?

Linney: The glass itself hasn't got infinite bandwidth, but it's effectively true. If you look at core networks, for example, you'll see a single strand of glass which is carrying terabits of capacity using multiple wavelengths and very clever signal processing and coherent optics.

The fibre itself, once it's in the ground, is going to meet our needs for as long as you can possibly imagine. I am a physicist at heart, so I could tell you there is a finite capacity in it, but you don't need to worry about it for access networks.

They're currently developing Very High Speed PON (VHSP), and that's a study Openreach is involved in, looking at 100Gbits/sec and beyond. And some people have even mentioned up to 800Gbits/sec for the next technology beyond 50Gbits/sec. So we're already doing the work on the science and the engineering to work out what the next step up is going to be.

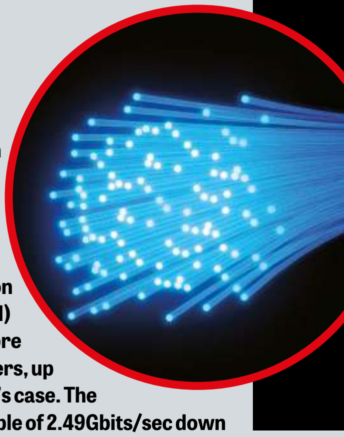
ONCE A PON A TIME...

Here's a quick summary of the technologies that Openreach will be deploying over the next decade.

GPON

Gigabit Passive Optical Network

The broadband technology being used by Openreach and others now. It uses time-division multiplexing (TDM) and wavelength-division multiplexing (WDM) to share a single fibre among multiple users, up to 32 in Openreach's case. The technology is capable of 2.49Gbits/sec down and 1.24Gbits/sec up, shared between all users of that single fibre.



XGS-PON

10-Gigabit Symmetrical Passive Optical Network

Already starting to be deployed by Openreach when it lights up new areas, XGS-PON bumps the top speed up to 10Gbits/sec in both directions. It can co-exist with GPON on the same infrastructure thanks to WDM, meaning the broadband providers can offer a greater range of speeds to customers.

50G PON

50-Gigabit Passive Optical Network

This is the technology used by Openreach in its Ipswich trial. As the name suggests, this delivers a five-fold increase in download speeds over the previous generation, with the ability to offer 50Gbits/sec upstream too – although operators can set slower upload speeds if they feel there's less demand for upstream traffic. It's unlikely that we're going to see this technology rolled out commercially before the 2030s. ●

BELOW Openreach currently uses GPON technology, which is limited to speeds of 2.49Gbits/sec down and 1.24Gbits/sec up

openreach
BT

The A-List

The best products on the market, as picked by our editors

PREMIUM LAPTOPS

Apple MacBook Pro M4

M4 beast from £1,599

from apple.com/uk

This M4 update to the already brilliant MacBook Pro line is an easy recommendation, so the big question becomes do you choose the 14in version from £1,599 or 16in from £2,499? And then how much do you upgrade, as Apple isn't afraid of high prices. But whatever you choose should last for years, and look great while it's doing it. **REVIEW Issue 364, p50**

Apple Mac Book Air 13in (M3)

Both the 13in and 15in MacBook Airs impress for speed, styling and battery life, but the 1.2kg 13in Air wins out of the two for its sheer portability. **From £1,299 from apple.com** **REVIEW Issue 356, p54**

Asus Zenbook S 14 OLED

Asus pairs a Core Ultra 9 288V with a 72Wh battery to produce a laptop that lasts almost 20 hours on a charge. What's more, this 1.2kg machine looks (and feels) the business. **From £1,750 from scan.co.uk** **REVIEW Issue 362, p46**

Asus ProArt PX13

With AMD's new Ryzen AI 9 HX 370 inside, this 1.4kg compact powerhouse offers incredible amounts of power. Add a fantastic OLED screen and RTX 4070 graphics and it's a winner. **From £2,000 from uk.store.asus.com** **REVIEW Issue 361, p50**

BUSINESS LAPTOPS

Lenovo ThinkPad T14s Gen 6 (Snapdragon)

Copilot+ PC for £1,500 exc VAT

from lenovo.com

It's perhaps a controversial choice – and we wouldn't roll this out en masse – but if you're buying for executives or CTOs this cutting-edge Copilot+ PC, complete with a Qualcomm Snapdragon Arm processor, is a superb choice. Not only is it good value, it's light, it's fast and its all-day battery life is genuinely 24 hours. **REVIEW Issue 360, p56**

Lenovo ThinkPad X1 Carbon Gen 12

The X1 Carbon range has stepped up a gear thanks to Intel's Core Ultra chips, and Lenovo matches it with the stunning build quality and keyboard you'd expect. **From £1,375 from lenovo.com** **REVIEW Issue 358, p58**

Dell Latitude 9450 2-in-1

This 14in convertible, based around Core Ultra CPUs, lacks for nothing, whether that's speed, battery life (around 16 hours), build quality or flexibility. **From £1,560 exc VAT from dell.co.uk** **REVIEW Issue 361, p63**

HP OmniBook Ultra Flip

A top-quality 2-in-1 with a terrific 14in OLED panel, great build quality and superb battery life thanks to Intel's latest generation Core Ultra 7 processors. **From £1,699 from hp.com** **REVIEW Issue 365, p46**

COPILOT+ PCs

NEW ENTRY

Asus Zenbook A14

Sub-1kg style for an affordable £1,100

from uk.store.asus.com

ASUS Zenbook

It says something about this affordable and super-slim laptop that with its 14in OLED panel it could easily take pride of place in our premium laptops category. It has all the performance most people need and fantastic build quality. **REVIEW Issue 367, p58**

Lenovo Yoga Slim 7x (Gen 9)

A Snapdragon X1E-78-100 makes this a nippy Copilot+ PC, and the battery lasts over 16 hours despite the demands of its top-quality 14.5in OLED screen. **£1,350 from lenovo.com** **REVIEW Issue 361, p57**

Microsoft Surface Laptop, 7th Edition

The poster child for Copilot+ PCs offers quality, great looks and staggering battery life. **From £1,049 from microsoft.com** **REVIEW Issue 360, p50**

Asus Zenbook S 15 OLED

With a price drop to £1,200 this 15.6in laptop becomes a viable competitor to the Yoga Slim 7x if you need a bigger screen. **£1,200 from uk.store.asus.com** **REVIEW Issue 359, p52**

EVERYDAY LAPTOPS

Acer Aspire 14 A14-51GM

Compact power for £850

from acer.com

Want gaming power? Buy the version with RTX 2050 graphics for £850 (part code NX.KSVEK.005). Just care about value? Get a Core 5 processor and integrated graphics for £600 (part code NX.KRWEK.00B). Whichever you choose, it's a staggering laptop for the price. **REVIEW Issue 359, p82**

Asus Zenbook 14 OLED (UX3405)

If you can stretch past £1,000, this is a top-quality Core Ultra laptop with a superb 120Hz screen and great battery life. **From £1,099 from uk.store.asus.com** **REVIEW Issue 359, p58**

Framework Laptop 13 (DIY Edition)

With a competitive price, modular approach and easy-to-repair ethos, you can pick and mix your perfect 13in laptop. **From £779 from frame.work** **REVIEW Issue 360, p58**

Huawei MateBook D16

It's big and certainly not bashful, packing an Intel Core i9 chip and a high-quality 16in panel – and surprisingly good battery life, too. **£1,000 from huawei.com** **REVIEW Issue 359, p87**

CHROMEBOOKS

Samsung Galaxy Chromebook Plus (2024)

Core 5 power for £749

from samsung.com

The first truly desirable Chromebook since the Pixelbook, this is a top-quality laptop from the all-metal chassis to the 15.6in Full HD OLED screen. And thanks to Intel's Core 5 120U processor, it's fast enough to last for years.
REVIEW Issue 364, p65

Acer Chromebook Plus 515

This Chromebook Plus laptop is all about value. With strong speeds thanks to Intel's Core i5-1235U processor, and a good-quality 15.6in panel with a 1,920 x 1,080 resolution, Asus' Chromebook Plus 515 is ideal for families, students and business users, providing mobility isn't your main priority as it isn't particularly light at 1.7kg. **£429 from currys.co.uk**
REVIEW Issue 356, p82

Acer Chromebook Spin 714

If you're looking for a convertible, this is the best choice around. Others may beat the 12th gen Intel Core i5 we tested for performance, but for features, design and bang for buck you won't find any laptop that can match this 2-in-1 for the money. **£799 from currys.co.uk**
REVIEW Issue 356, p83

MINI PCs

NEW ENTRY

Apple Mac mini M4

Little monster from £599

from apple.com/uk

This is a big and timely update for the Mac mini, with a much smaller (and squarer) design that's easy to tuck behind a screen. But what lifts it above the pack is the astonishing power of the M4 and M4 Pro chips, with barely any cooling required. As ever with Apple the upgrade costs are high, but at least its starting price is reasonable.
REVIEW Issue 364, p44

Geekom A6 Mini PC

The Geekom A6 Mini PC steals the A8's place on our A List thanks to its sheer value for money. The A6 costs £220 less but doesn't compromise on quality or connectivity, and while the Ryzen 7 6800H is a step down from the Ryzen 9 8945HS in the A8, it remains a superb performer.
£499 from geekom.co.uk
REVIEW Issue 367, p56

Minisforum Venus UM790 Pro

Ignore its basic looks, for this compact system packs in a fast AMD Ryzen 9 7940HS processor, 32GB of DDR5-5600 RAM and 1TB SSD along with a generous selection of ports, including two USB-C 4 connectors. And the price is super-aggressive.
£549 from store.minisforum.uk
REVIEW Issue 363, p91

ENTHUSIAST PCs

NEW ENTRY

Scan 3XS Edge iCue

Silent but deadly fast for £2,800

from scan.co.uk

With the RTX 5080 comes a refresh of best enthusiast PCs. The Scan is a shade slower than its Ryzen 9 9800X3D rival from Wired2Fire, but even at full pelt it remains astonishingly quiet.
REVIEW Issue 367, p50

NEW ENTRY

Wired2Fire R7X3D RTX 5080 Beast Gaming PC

A great-value system, with a Ryzen 9 9800X3D, RTX 5080 graphics, 64GB of RAM and a 2TB SSD inside the striking Be Quiet Light Base 600 LX chassis. Not the quietest, but it's super-powerful. **£2,800 from wired2fire.co.uk**
REVIEW Issue 367, p52

NEW ENTRY

CyberPowerPC Infinity Z890 Elite PC

Treading the Intel path with a Core Ultra 9 285K CPU, this RTX 5080 system packs the Lian Li Lancool 207 chassis with top-quality components – including Kingston Fury RAM (32GB) and a 2TB SSD. **£2,999 from tinyurl.com/367cyberpower**
REVIEW Issue 367, p53

ALL-IN-ONE PCs

HP Envy 34 All-in-One

£2,099 widescreen wonder

from hp.com

Built around a high-quality 34in widescreen – which is perfect for viewing two windows side by side thanks to its 21:9 aspect ratio – this also comes with Nvidia RTX 3060 graphics. We're big fans of the magnetic 16-megapixel camera, too.
REVIEW Issue 335, p46

Dell Inspiron 24 All-in-One

Despite being built to hit a price point, the Inspiron 24 All-in-One manages to look classy, include a good-quality, 1,920 x 1,080 24in panel and have enough power to breeze through a typical day's tasks. It even packs mod cons such as a 720p webcam. Superb value for money.
From £599 from dell.co.uk
REVIEW Issue 350, p47

Apple iMac M4

Anyone hoping for a 27in iMac will be disappointed, but everyone else should be delighted by this M4-powered all-in-one with its 24in 4,480 x 2,520 IPS panel. It's fast inside and out, too, with Thunderbolt 4 and Wi-Fi 6E both part of the package. **From £1,299 from apple.com/uk**
REVIEW Issue 364, p48

CREATIVE WORKSTATIONS

Armari Magnetar M64T7-AW1650G4

Threadripping power for £8,329 exc VAT

from armari.com

AMD's Ryzen Threadripper 7980X is the star of this particular show, dominating our benchmarks with the help of 128GB of RAM, two 2TB Crucial PCI-E 5 drives in RAIDO configuration and AMD's Radeon Pro W7800 professional GPU. And it's all wrapped up in a custom Armari case with liquid cooling.
REVIEW Issue 361, p92

PCSpecialist Quantum Goliath R

Extracting maximum power from its budget by opting for consumer components with professional levels of power, this well-thought-out workstation couples Intel's Core i9-14900KS with RTX 4090 graphics to tremendous effect. **£3,750 exc VAT from pcspecialist.co.uk/reviews**
REVIEW Issue 361, p89

Scan 3XS GWP A1-TR64

A more balanced offering than Armari's Magnetar, Scan mixes a Threadripper 7970X with Nvidia RTX 5000 graphics – and a stunning supporting cast of components with an equally stunning case. Perfect for real-time viewsets and GPU accelerated computation.
£7,917 exc VAT from scan.co.uk
REVIEW Issue 361, p94

TABLETS

Apple iPad Air (M2)

M2 power from £599

from apple.com

We love the new iPad Pro, but for most people the M2 iPad Air is not only far better value but also all the tablet they'll need. It supports the Magic Keyboard and Pencil Pro, plus it's now available in both 11in and 13in sizes.
REVIEW Issue 358, p50

Apple iPad Pro (M4)

The best tablet in the world becomes even better thanks to Apple's stunning M4 chip, a gorgeous OLED screen and the must-have accessory: the all-new Pencil Pro. But it comes with an obvious downside of cost, with the cheapest 13in incarnation costing £1,299. **From £999 (11in, 256GB) from apple.com**
REVIEW Issue 358, p48

OnePlus Pad 2

Last year the OnePlus Pad took its place alongside Apple's iPads on the A List – and this year it's done it again, with superb battery life of over 18 hours, a gorgeous design and great power making this new version an even better proposition. All for a price that's exactly right. **£449 from oneplus.com/uk**
REVIEW Issue 364, p86

EVERYDAY PHONES

Motorola Moto G54 5G

Great looker for £180

from johnlewis.com

The 6.5in 120Hz IPS display is the G54's standout feature, but it improves on the previous generation in numerous ways while being even cheaper. It's faster, looks better, takes great photos and battery life is strong. You won't find better for less than £200.
REVIEW Issue 355, p77

motorola
moto g54
5G

Google Pixel 8a

We're fans of the Pixel 8 but you can save £200 and buy the 8a without missing out on any key features, including its advanced AI skills thanks to the same Tensor G3 chip inside. It's only when you zoom into snaps that you spot the camera quality difference. **128GB, £499 from store.google.com**
REVIEW Issue 358, p74

Samsung Galaxy A55

Not the fastest phone on the market, but in return you get a high-quality 6.6in OLED display, excellent battery life and a trio of strong cameras. And you also get four years of feature updates. With a price that significantly undercuts the Pixel 8a, it's great value, too. **128GB, £364 from johnlewis.com**
REVIEW Issue 358, p77

PREMIUM PHONES

NEW ENTRY

Samsung Galaxy S25 Ultra

AI in your hand from £1,249

from samsung.com/uk

So good it tempted our reviewer – an iPhone devotee – to move to the other side. That's thanks to the faultless hardware, brilliant photography performance and Samsung's slick AI, not to mention the integrated S Pen stylus. It's not cheap, but you're buying for the long term with seven years of OS updates.
REVIEW Issue 367, p70

Honor Magic V3

With the Magic V3, not only does Honor make foldable phones as slim as flagship phones but also as affordable – so long as the £300 discount voucher still applies, as shown in the price here. What's more, the cameras and both OLED panels are superb. **£1,400 after discount from honor.com**
REVIEW Issue 362, p62

Apple iPhone 16 Pro

Even without Apple Intelligence, the introduction of a 5x optical zoom, classy 6.3in OLED panel and Apple's ludicrously fast A18 Pro chipset make this the best update to an iPhone Pro for years. And if you need one more reason to buy, how about its much improved battery life? **128GB, £999 from apple.com/uk**
REVIEW Issue 363, p70

EVERYDAY MONITORS

Iiyama ProLite XUB3293UHSN-B5

32in 4K bargain, £429

from currys.co.uk

The fact that this 31.5in IPS monitor could compete so well against Eizo's alternative (*see below*) says it all. Great colour coverage in sRGB and DCI-P3, USB-C and RJ45 inputs, plus solid build quality add up to a bargain.
REVIEW Issue 357, p88

AOC Q27B3CF2

AOC's relentless focus on value delivers a 27in 1440p screen with a high-quality IPS panel that costs £200 including VAT – and also packs in a USB-C port. Those are almost the only features you get, and the OSD is awful, but at this price we're not complaining. **£200 from amazon.co.uk**
REVIEW Issue 360, p77

Acer Verso B277 Ebmiprzxv

This is a basic but high-quality monitor, delivering colourful images across its 27in Full HD diagonal. You don't get USB-C docking, but it includes VGA, HDMI and DisplayPort inputs, plus a two-port USB hub. **£149 from tinyurl.com/357acer277**
REVIEW Issue 357, p84

PROFESSIONAL MONITORS

Eizo FlexScan EV3240X

Stunning 4K quality, £1,206

exc VAT from photospecialist.co.uk

With images that whack you between the eyes as soon as you lift it, fully assembled, from its box, this 32in 4K monitor is our top choice pick for anyone willing to make such a hefty long-term investment.
REVIEW Issue 357, p91

Eizo ColorEdge CG2700X

A brilliant choice for professional designers, whether working solo or in teams, thanks to its dedication to providing accurate colours across potentially years of life. It's also bang up to date for connectivity, with USB-C and RJ45 making it easy to manage, too. **£2,149 exc VAT from wexphotovideo.com**
REVIEW Issue 357, p90

BenQ PD2706U

If you can't stretch to Eizo budget levels then this 4K 27in screen is definitely worth investigating. It has several features aimed at professionals, including a Hotkey Puck to switch between profiles, plus great coverage of the sRGB and DCI-P3 gamuts. **£333 exc VAT from scan.co.uk**
REVIEW Issue 357, p86

WEBCAMS

Logitech MX Brio 705 for Business

Consistent brilliance for £219

from logitech.com

Consistent image quality in all lighting conditions coupled with top build quality and nifty features – such as a presenting mode for items on your desk – make this a fantastic all-round choice.
REVIEW Issue 356, p68

Logitech Brio 105 for Business

While you can buy 1080p webcams for a third of the Brio 105's price, they won't hold a candle to the Logitech webcam's quality – especially in low-light conditions, such as one candle. It's also easy to manage, for businesses and individuals.
£45 from logitech.com
REVIEW Issue 360, p77

Obsbot Tiny 2

This portable 4K webcam delivers for quality, design and sharpness, and it comes with a shedload of advanced features, including dynamic zoom and subject tracking. The only real downside is that it has a price that reflects its premium ambitions.
£329 from amazon.co.uk
REVIEW Issue 352, p75

HOME OFFICE PRINTERS

HP OfficeJet Pro 9135e

Do-it-all inkjet for £193

from printerbase.co.uk

This versatile inkjet all-in-one – which includes a 35-page ADF – pumps out high-quality prints at laser-rivalling speeds. Likewise scans and copies. Print costs are reasonable, too.
REVIEW Issue 365, p85

Epson EcoTank ET-2865

As usual with ink tank printers, you don't get many frills with the Epson EcoTank ET-2865 (so no ADF or screen). What you do get is incredibly low running costs of 0.5p for colour and 0.2p for mono, plus high-quality prints and scans.
£233 from uk.insight.com
REVIEW Issue 365, p84

Canon i-Sensys LBP243dw

Everything you could want from a mono laser printer – it doesn't come with a scanner – the LBP243dw produces excellent results at speed. You also get Wi-Fi and wired networking. **£186 from printerbase.co.uk**
REVIEW Issue 365, p88

WORKGROUP PRINTERS

Canon Maxify GX6550

Ink tank all-in-one for £392 exc VAT

from canon.co.uk

Designed to fit in tight spaces, this all-in-one includes a highly effective ADF and backs it up with high-quality prints at 24ipm in our tests. Running costs are superb, too.
REVIEW Issue 350, p58

Brother HL-L9430CDN

This laser printer (not an all-in-one, so there's no scanning or copying functionality) is a great choice for a busy office, producing sharp black text and making a good job of colour graphics as well. All while doing so quickly with a competitive price per page. **£415 exc VAT from printerland.co.uk**
REVIEW Issue 353, p84

Xerox B315DN

A fine alternative to the Brother and Canon, this mono laser multifunction printer produces superb results at great speed – 27.5 pages per minute in our 50-page test, which includes the spool time. It's similarly quick for scans, with a dual-CIS ADF to speed up double-sided copies. **£238 exc VAT from printerbase.co.uk**
REVIEW Issue 341, p87

WIRELESS ROUTERS

Netgear Nighthawk RAXE300

Fast Wi-Fi 6E router, £350

from amazon.co.uk

The RAXE500 is faster than the RAXE300, but in practice we doubt you would notice – this tri-band router still delivered speeds between 50MB/sec and 150MB/sec in our tests. And it's packed with features, too. At £150 cheaper than its bigger brother, we think it hits the Wi-Fi 6E sweet spot.
REVIEW Issue 341, p68

Netgear Nighthawk RS700S

Make no mistake – you won't get stunning speeds out of this Wi-Fi 7 router today. But if you must buy a router now and want future-proofing, this is a solid choice. But honestly, we would recommend that you wait.
£800 from netgear.com
REVIEW Issue 353, p76

Asus RT-AX59U

You can buy cheaper Wi-Fi 6 routers – such as the D-Link Eagle Pro AI R15 for £55 – but Asus' well-priced offering delivers strong performance along with lots of control and exceptional VPN support. **£125 from uk.store.asus.com**
REVIEW Issue 350, p57

MESH WI-FI

TP-Link Deco XE200

Clever Wi-Fi 6E for £400

from amazon.co.uk

There are cheaper Wi-Fi 6E meshes, but the XE200 wins for its superb download speeds, excellent coverage and the fact that older clients reap benefits of 6E, not just new ones. And a two-pack (code B0BKTDPWC8) should be enough for most premises.
REVIEW Issue 349, p65

Netgear Orbi 770

If you're eager to upgrade to Wi-Fi 7 then the Orbi 770 is the best mesh option yet. Its speed and range are both excellent, with a twin-pack covering 420m² (says Netgear), and the wired connectivity superb: four 2.5GbE connectors on the router unit, two 2.5GbE ports on the satellites. But it ain't cheap. **2-pack, £600 from amazon.co.uk**
REVIEW Issue 364, p70

Linksys Velop Pro 6E

Ironically, this Wi-Fi 6E router will get the most out of your non-Wi-Fi 6 devices thanks to its use of the 6GHz network for station-to-station traffic. And you only need two units for rock solid performance across a three-bedroom house. **2-pack, £380 from amazon.co.uk**
REVIEW Issue 350, p54

BUSINESS WI-FI

Ubiquiti UniFi U7 Pro Max

Wi-Fi 7 AP, £214 exc VAT

from broadbandbuyer.com

A great choice for SMBs seeking a powerful and affordable upgrade to Wi-Fi 7. You'll need a UniFi controller to complete the wireless picture, but this investment will be paid back handsomely as they offer the best cloud management services around.
REVIEW Issue 365, p100

TP-Link Omada EAP783

This slim-line discus has a mighty BE19000 rating and will appeal to businesses looking to make an early transition to Wi-Fi 7. It delivers superb performance and is MLO-ready, while TP-Link's Omada cloud platform offers great remote management services. **£520 exc VAT from senetic.co.uk**
REVIEW Issue 360, p103

EnGenius ECW526

The ECW526 is a top choice for SMBs looking to make the move to Wi-Fi 7 as it combines a great feature set at a tempting price. Cloud management services are extensive, and its potent Qualcomm CPU and 10GbE port deliver superb wireless performance. **£225 exc VAT from solwise.co.uk**
REVIEW Issue 366, p102

NAS SERVERS

Synology DiskStation DS1823xs+

10GbE NAS, £1,413 exc VAT

from broadbandbuyer.com

This powerful eight-bay NAS is a great choice for SMBs that want plenty of capacity, features and performance at a reasonable price. The new DSM 7.2 software has security high on its agenda, and the icing on the cake is Synology's generous five-year warranty.
REVIEW Issue 346, p101

Qnap TS-h987XU-RP

The TS-h987XU-RP is a ready-made hybrid storage solution for SMBs. This rack-friendly package offers a great specification for the price, and Qnap's QuTS hero software scores highly for its wealth of data-protection features and business apps. **Diskless, £3,292 exc VAT from broadbandbuyer.com**
REVIEW Issue 344, p96

Synology DiskStation DS1522+

Small businesses that want a high-capacity desktop NAS at a good price will find Synology's DS1522+ a great choice. Performance over 10GbE is impeccable and the DSM software offers a fantastic range of storage features. **5-bay NAS, diskless £586 exc VAT from broadbandbuyer.com**
REVIEW Issue 344, p98

VIDEOCONFERENCING

Biamp Parlé VBC 2800

Go big for £2,918 exc VAT (MSRP)

from midwich.com

We thought the VBC 2500 was a great VC room bar, and the new VBC 2800 delivers Biamp's undeniable expertise to larger meeting rooms. Video and audio quality are outstanding, speaker framing is super fast and the smart combination of dual camera lenses makes sure everyone is in the big picture.
REVIEW Issue 364, p98

Owl Labs Medium Room Solution

The Owl 4+ and Owl Bar partnership offers smart tracking and dynamic split-screen views to ensure everyone is in the picture, while the Whiteboard Owl adds extra professionalism to presentations and training sessions. **Owl 4+, Owl Bar, TV mount, £2,999 exc VAT from owllabs.co.uk**
REVIEW Issue 364, p100

Ricoh Meeting 360

Ricoh's Meeting 360 is up against stiff competition in the panoramic meeting hub market but stands out for its excellent build quality and generous three-year warranty. It's easy to use and delivers good video and audio quality, while the smart app allows you to create a view for every occasion. **£744 exc VAT from amazon.co.uk**
REVIEW Issue 364, p101

SCANNERS

Xerox N60w Pro Scanner

Speed demon, £766 exc VAT

from tradescanners.com

The N60w Pro offers tremendous value and versatility. It delivered up to 67ppm in our tests with great output quality, offers a plethora of connection options and makes walk-up scanning a breeze.
REVIEW Issue 358, p101

Brother ADS-4500W

Ideal for small businesses, the ADS-4500W offers a fine set of walk-up scan features and its output quality is beyond reproach, while Brother's Print&Scan app delivers great scan workflow management options. **£295 exc VAT from printerbase.co.uk**
REVIEW Issue 358, p98

Epson WorkForce DS-800WN

A flexible desktop scanner with 50ppm pace and lots of connection options. Epson's software provides great scan management features, and support for Epson's Open Platform is a boon for document management. **£656 exc VAT from ballicom.co.uk**
REVIEW Issue 365, p103

SECURITY APPLIANCES

Firewalla Gold Pro

Top-value protection for $899 (£676)

from firewalla.com

Firewalla
Gold PRO

A great choice for SMBs that delivers a wide range of security features at a tempting price. Our 10GbE tests show it can easily cope with high demand, and don't worry about subscriptions as the price includes all security services and lifetime updates.
REVIEW Issue 364, p103

DrayTek Vigor 2927Lax-5G

This affordable security router is a particularly good choice for smaller businesses. It offers always-on internet access thanks to an unbeatable set of WAN redundancy features whilst building in still-speedy Wi-Fi 6 services. **£667 exc VAT from broadbandbuyer.com**
REVIEW Issue 360, p98

WatchGuard Firebox M390

The Firebox M390 combines strong performance with an incredible range of security measures at a competitive price. It's easy to deploy and a cloud portal delivers remote management and monitoring services. **Appliance with 1yr TSS subscription £4,273 exc VAT from broadbandbuyer.com**
REVIEW Issue 360, p100

SECURITY SOFTWARE

Avira Prime

Avira wins for all-round AV performance, plus a solid VPN, for a fair price. Watch out for a second-year hike to £91, though. **First year: 5 devices, £52 from avira.com**

REVIEW Issue 366, p84

Bitdefender Total Security

A long-term award winner in our security suite Labs, Bitdefender continues to charm for its consistent AV performance, solid feature set and extremely competitive price. **5 devices, 1yr, £20 from store.pcpro.co.uk**

REVIEW Issue 366, p85

Avira Free Antivirus

There's absolutely no need to pay for a full security suite if you only want antivirus protection, and Avira is our top choice simply due to its excellent and consistent performance in tests. **Free from avira.com**

REVIEW Issue 366, p89

VPNs

Surfshark

Reliably fast and goes out of its way to ensure that international streaming services work. Surfshark has a credible track record for privacy, too. **£55 for 27 months from surfshark.com**

REVIEW Issue 360, p87

NordVPN

One of the best all-purpose consumer VPN services around, and the paid-for version is packed with features – from anti-malware tools to a rather clever mesh file-transfer system. **£94 for 27 months from nordvpn.com**

REVIEW Issue 360, p85

Proton VPN

A great VPN in its own right, but also the best free VPN service as you get unlimited data. Instead, Proton restricts which endpoints you can access to only three countries: the USA, the Netherlands and Japan. **Free from protonvpn.com**

REVIEW Issue 360, p86

LINUX DISTROS

NEW ENTRY

Ubuntu

A fine choice for Windows switchers thanks to its familiar design, with regular six-monthly updates and a Long Term Support version. **Free from ubuntu.com**

REVIEW Issue 367, p92

NEW ENTRY

Fedora Workstation

One of the longest-established distros, and with a strong link to Red Hat Enterprise Linux, Fedora Workstation will particularly appeal to business migrators. **Free from fedoraproject.org**

REVIEW Issue 367, p85

NEW ENTRY

Linux Mint

There's a good reason this is a popular choice for Windows 10 refugees, including a familiar "Start menu", and it's easy to give it a trial before committing. But consider Zorin OS, too. **Free from linuxmint.com**

REVIEW Issue 367, p86

ON-PREMISES BACKUP

Nakivo Backup & Replication 10.11.2

Perfect for SMBs that want the freedom to choose their host system. It supports an incredible range of hardware platforms and OSes and is packed with data protection features. **Enterprise, 10 servers, perpetual licence, £1,118 exc VAT from nakivo.com**

REVIEW Issue 362, p100

Veritas Backup Exec 23

Backup Exec 23 is easy to manage, provides valuable ransomware protection and the subscriptions are great value. **Simple Core Pack, 5 instances, £498 exc VAT per year from uk.insight.com**

REVIEW Issue 362, p101

NETWORK MONITORING

Progress WhatsUp Gold 2024

A great SMB choice as it presents a clear picture of your network and is available in a wide range of licensing plans. It's a cinch to deploy, doesn't require a lot of host resources and the new features make it even easier to customise. **Enterprise, 50 devices, £1,177 exc VAT per year from whatsupgold.com**

REVIEW Issue 366, p100

Park Place Technologies Entuity 22

An impressive toolbox of monitoring services all easily managed from a web console that offers a wide range of informative dashboards. **From $150 per node/year from parkplacetechnologies.com**

REVIEW Issue 366, p99

VOIP SERVICES

3CX Phone System V20

Our top choice for businesses that want to manage their own VoIP system. It can be hosted in the cloud or on-premises, and has lots of new features. **Small Business, 10 users, £175 exc VAT per year from 3cx.com**

REVIEW Issue 357, p98

TelephoneSystems.Cloud

A great choice for businesses that know what they want from cloud-hosted VoIP services, offering a wealth of features at a good price. **From £11 exc VAT per user per month from telephonesystems.cloud**

REVIEW Issue 357, p100

ENDPOINT PROTECTION

WithSecure Elements Endpoint Security

A comprehensive set of protection measures for a great price, easily managed from a cloud portal. It supports a wide range of devices and the Luminen tool delivers AI-powered reporting services that present detailed summaries of events with a click. **100-499 devices, £37 exc VAT each per year from withsecure.com**

REVIEW Issue 363, p101

Sophos Intercept X Advanced

An unbeatable range of tough security measures. Deployment is a breeze, and a multitude of security policies make it highly flexible. **100-199 users, £48 exc VAT each per year from enterpriseav.co.uk**

REVIEW Issue 363, p98

REMOTE SUPPORT

NetSupport Manager 14.1

Sets the standard for on-premises hosted support for local and remote workers. It delivers a remarkable range of features and its one-time cost per seat will appeal to businesses concerned about subscription fees. **1-500 systems, perpetual licence, £10 each exc VAT from netsupportmanager.com**

REVIEW Issue 361, p100

ISL Online Standard

Perfect for SMBs wanting cloud-based support. Features and access security are excellent, as are its flexible licensing plans. **Standard Cloud/One user, £287 exc VAT per year from islonline.com**

REVIEW Issue 361, p99

CLOUD FILE-SHARING

NEW ENTRY

Progress ShareFile Premium

Progress ShareFile Premium will appeal to SMBs seeking affordable and easily managed cloud collaboration services. It offers plenty of app integrations plus support for large file sizes, and the AI-powered features deliver smart security measures. **£19.90 exc VAT per user per month billed yearly from sharefile.com**

REVIEW Issue 367, p98

NEW ENTRY

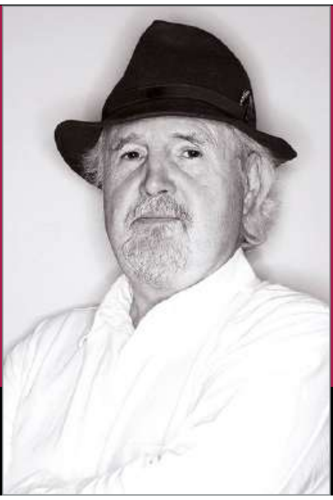
Dropbox Business Plus

Collaboration tools, app integrations and a huge maximum file size limit – plus malware scanning and data classification – make this a great choice. **£18 exc VAT per user/month billed yearly from dropbox.com**

REVIEW Issue 367, p96

A short reading list for tech bros

It's time our quasi-leaders put down their science fiction and started educating themselves with something a little more meaningful instead



Dick Pountain is editorial fellow of *PC Pro* and hopes that Elon doesn't read his column. He doesn't want to be DOGEd. @dick-pountain

I used to think a monthly column was a relaxed schedule compared to, say, a daily newspaper. No longer. I had decided to do this one about how China upset the USA by doing AI on the cheap, but now I feel a need to check online every ten minutes for whatever new geopolitical atrocity has just overshadowed that. Besides, Nicole got there first. Nevertheless, I'll start with a nod to the original plan, of how China pulled down the knickers of the US AI bubbleheads.

I won't dive deep into the details of how DeepSeek succeeded in doing what ChatGPT does for a fraction of the price, or how it rocketed to the top of Apple's mobile-app store hit parade, nor how it did so by parasitising the US AI bros' data in just the same morally and legally unsavoury way they got it in the first place. Instead, I'd prefer to harp on about something I've been moaning about for 20 years: how the AI industry deludes itself because, led as it is by sci-fi-addled nerds (one of whom now appears to be the de facto POTUS), it has a severely limited grasp of biology and philosophy.

Two columns ago I expressed my opinion of OpenAI's plans to achieve artificial general intelligence, AGI, which it claims would confer human-level reasoning. One objection was its colossal power requirements, but my real objection is that I don't believe AGI is achievable by simply crunching more data. That's for reasons of biology I've explored here many times, namely that although human intelligence expresses itself through language – by manipulating symbols, which is all any computer can do – that's neither its only nor its most important source.

> **"The AI industry deludes itself because, led as it is by sci-fi nerds, it has a limited grasp of biology and philosophy"**

We're animals who have been equipped by evolution to succeed at living in a physical world, achieved with the help of our senses to sample what's going on around us. We build, continuously update and maintain a mental model of that world. We have needs – including eating, drinking, reproducing and avoiding predators – which are intimately entwined into that model. We're born with some built-in knowledge about gravity, upness and downness, light and shade, convexity and concavity, that control the model in ways of which we're not conscious, but which deeply affect our symbolic processing of that world. We're by no means just "rational".

Conversely, AI has learned how to pretend to be intelligent only by plundering our *symbolic representations* of the world, our texts and our pictures; it knows nothing, and can know nothing, of our embodied experience. Sure, it could build imitations of emotions and needs, but they'd just be more static representations, not extracted from the real world by living in it.

Historically, computers arrived thanks to advances in mathematics, then electronic engineering, so it's hardly surprising that the intellectual atmosphere in which they're embedded is more influenced by science fiction than by philosophy, anthropology or cognitive psychology. It may well be too late now for AI practitioners to go back and do the necessary reading, since they've reached a level of megalomania that convinces them they already know it all. Looking at the photos from this year's inauguration, it seems they have achieved power over the world's most powerful nation to prove it.

Were I to be asked to set the tech bros some homework I'd recommend first of all my favourite philosopher George Santayana and his theory of "animal faith", which enables us to navigate life's uncertainties by deploying our intrinsic knowledge and not "overthinking". That leads directly to the more modern version by Nobel Laureate Daniel Kahneman and his discovery of two modes of thought: the fast, imprecise-but-often-good-enough one, and the slow, symbolic one, which is all that computers can mimic.

> **"Smartphones are already more embodied than GPTs because they have senses (hearing, sight, touch, spatial orientation) and hunger (for charging)"**

Then I'd suggest George Lakoff and Mark Johnson's *Metaphors We Live By*, which explores the content of our intrinsic embodied knowledge and how it modulates our language. Oddly enough, smartphones are already more embodied than GPTs because they have senses (hearing, sight, touch, spatial orientation) and hunger (for charging). Fortunately, unlike their charging cables, they can't yet reproduce.

Having absorbed all that, they might dip into Chris Frith's *Making up the Mind*, the best explanation I've read of how the brain creates and updates the mind using Bayesian rather than Cartesian mechanisms. That ought to convince them they don't (or most likely don't want to) know it all.

But the final step would be by far the most difficult: to get them to take democratic politics seriously and divert their megalomaniac schemes toward improving life for the majority of the population rather than a feckless techno-elitist minority. Of course, certain of them may prefer to go to Mars, which would at least provide a rigorous education in embodiment.

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We should have seen DeepSeek coming

Regulators and ethicists warned that AI needed to consider efficiency, so how odd that China is the country that listened

Nicole Kobie is *PC Pro*’s Future’s editor. Her favourite AI misconception is that you can spot generated text because it uses a lot of em-dashes – you should see how many my editors have to take out.
@njkobie

Big Tech was hit by a DeepSeeking missile in January, with the Chinese AI sending shares into a spiral and sparking an existential crisis among (most) tech-bro CEOs. But we should have seen it coming – we were warned repeatedly, after all.

First, a step back for those who have tapped out of listening to every scrap of AI news. In January, DeepSeek released an LLM that could compete with the top US AI players yet requires much less processing power, chews through less energy and water (*see p126*) and is much cheaper to run. It manages this with some clever reinforcement learning techniques, but also by only using the parameters that are actually applicable to the task at hand, rather than all 671 billion of them. That gives it the scale required to compete with existing models while reducing its requirements.

You’d think we’d all applaud such cleverness, but DeepSeek is Chinese, so it’s a problem. But US tech firms not only *could* have built a similar system, they were told they *should*.

In 2020, the Google ethics team tried to publish a paper that called for the development of more efficient systems, because without them LLMs will become unnecessarily unwieldy and overuse resources. The researchers were reportedly told to change the paper, take off their names or not publish. They refused, and eventually two left; Timnit Gebru and Margaret Mitchell either quit or were fired, depending on who you talk to.

> “US tech firms not only could have built a similar system, they were told they should”

That now famous paper, known as “Stochastic Parrots”, should have been heeded. In the introduction, the authors noted: “What are the risks associated with this technology and what paths are available for mitigating those risks? We provide recommendations including weighing the environmental and financial costs first, investing resources into curating and carefully documenting datasets rather than ingesting everything on the web, carrying out pre-development exercises evaluating how the planned approach fits into R&D goals and supports stakeholder values, and encouraging research directions beyond ever larger language models.”

But their recommendations were ignored and LLMs kept getting bigger. So you’ll forgive Gebru for her reaction to DeepSeek: “No one & and I mean NO ONE wanted to listen to us when we screamed at the top of our lungs that the emperor has no clothes...” They weren’t alone in raising concerns. Lina Khan departed as head of the FTC, the regulatory body that covers these subjects in the US, ahead of Trump’s inauguration, but even Kamala Harris’ donors were calling for her to be sacked before the election. Why? Because Khan was tough on Big Tech.

After DeepSeek sparked a panic, she noted in a column for the *New York Times* that Big Tech AI developers have been pushing to shut out China and other competitors for years, begging for “special protections that close off markets and lock in their dominance”.

Despite Big Tech’s advantages, she noted, they were caught off guard by DeepSeek. “DeepSeek is the canary in the coal mine,” she wrote. “It’s warning us that when there isn’t enough competition, our tech industry grows vulnerable to its Chinese rivals, threatening US geopolitical power in the 21st century.”

Indeed, there are reports that one reason DeepSeek sought efficiency was export bans on Nvidia’s top chips; if true, and it’s unclear if it is, it would mean the tariffs designed to slow China’s innovation have backfired.

None of this means that the existing models from Open AI et al are worthless – there have been suggestions that some of its work was nicked by DeepSeek – or that efforts to invest in data centres to power hungry AI are all for nothing. After all, making a massive system more efficient enables us to build even more massive systems, and making an expensive system cheaper and more accessible simply means it will be used more.

> “Had Big Tech listened to critics, American AI companies would have had a four-year head start building what DeepSeek created”

But had Big Tech listened to critics – whether its own ethics staff or regulators – American AI companies would have had a four-year head start building what DeepSeek created. Open AI et al could have been ahead of DeepSeek, rather than caught unaware. We’d already have all the benefits promised by this different way of thinking about LLMs.

So why didn’t Big Tech listen to Lina Khan, Timnit Gebru or Margaret Mitchell, only snapping to attention when DeepSeek landed? Perhaps they didn’t believe it was possible. Perhaps they need to learn to accept criticism as a tool in innovation, rather than see it as a challenge to their success. Perhaps activists and regulators shouldn’t be seen as the enemy, but part of the team – after all, they’re dedicating their lives to making technology better.

Do you think Big Tech will learn this lesson? After 20 years of doing this job, sadly I know they won’t.

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Full fibre, half the speed

Under-par routers aren't keeping pace with Britain's ever-faster broadband lines, which is choking back speeds and progress

Barry Collins is a former editor of *PC Pro*. He doesn't get out of bed for less than a gigabit. Email him at barry@pcpro.co.uk. @bazzacollins

There's no doubt that an awful lot of whoosh has been added to British broadband connections over the past few years. Ofcom reports that more than 83% of British homes now have access to gigabit broadband, which is phenomenal given that, a decade ago, the fastest anyone could get was 200Mbits/sec and the average download speed in the UK was a piddling 3.7Mbits/sec.

Don't adjust your sets. This isn't one of my twice-in-a-lifetime uplifting columns; there's an almighty caveat coming. Because for all the progress we've made at the network end of broadband connectivity, the final bit – the router that beams all those lovely megabits around your home – is likely well behind the times.

I've recently been doing a bit of work surveying the offerings from the country's biggest broadband providers, and it's depressing stuff. Order a 900Mbits/sec connection from BT Broadband today and you'll be supplied with a BT Smart Hub 2, the router it launched back in 2018. It's based on Wi-Fi 5 (802.11ac), which is two whole generations behind the current Wi-Fi 7 gear – three if you count Wi-Fi 6 and Wi-Fi 6E as distinct technologies. It's 4x4 MIMO across two bands, so can theoretically hit 3.6Gbits/sec, but we all know Wi-Fi theoretical maximums are about as achievable as back-to-back wins on Euromillions.

Darien tells me the fastest speed he ever recorded when testing a Wi-Fi 5 router was around 240Mbits/sec. That roughly jibes with the experience of the BT customers griping about the Smart Hub 2 on Reddit, who report that the maximum they can get is 400Mbits/sec if they're sitting right in front of the router. "In the next room, [I'm] lucky to get 250Mbits/sec consistently," one moans. The supplied router can't get anywhere near the speeds they're paying for.

BT isn't the only one banging out this old kit. BT subsidiary Plusnet is relying on Wi-Fi 5 routers, as is Sky for every tariff except its top-whack gigabit lines. Virgin still bangs out Wi-Fi 5 gear on some of its cheaper tariffs. And these are new orders. When did your broadband provider last voluntarily upgrade your router? This kit will likely still be in people's homes in four or five years' time, when line speeds have grown even faster.

> **"We all know Wi-Fi theoretical maximums are about as achievable as back-to-back wins on Euromillions"**

Of course, they're not shy about upselling you extras to make up for the deficiencies of this near-obsolete gear. BT will flog you Wi-Fi Discs – BT-branded Wi-Fi extenders to dot around your home – for an extra £10 per month on top of your monthly fee, so "you'll be able to browse, stream and videocall in every room". Yet in the average-sized home any half-decent router should already reach every room with speeds fast enough for Netflix or Zoom calls. You shouldn't have to fork out an extra £120 a year for that capability.

The other wheeze is the 4G fallback add-ons. I could just about get on board with this if they embedded SIM slots in the main routers and fell back on 4G/5G if the landline went down, but more often than not they're separate devices, requiring separate power, that are going to sit there doing nothing but trickling away electricity for 364 days of the year. And they want you to pay extra for the privilege! BT's Hybrid Connect costs £7.55 per month, while Vodafone will charge you £13 extra on a 150Mbits/sec line for 4G backup and other benefits. Given that the majority of broadband outages are likely to be down to the provider, not you, charging you a king's ransom to guard against their failings is breathtaking brass neck.

> **"For all the progress Britain has made with broadband speeds, it's choked back by the dismal routers that sit in tens of millions of homes"**

Now, you're a *PC Pro* reader. I'm sure you're avidly scanning through Darien's router reviews, as keen as I am to find out how many megabits per second he's getting in his (new) bathroom, so you can kit yourself out with a zinging home network. But many broadband providers aren't keen on third-party kit. "You must use a Vodafone router with our Pro Broadband plans and any plan with Digital Voice," states Vodafone, for example. "We can't support with the setup of third-party equipment," warns EE, to name but two. So if you do decide to dump their kit, you're on your own if you can't get it to work or run into technical problems. Only providers of Zen's calibre – who supply decent equipment in the first place – are happy to help if you've connected your own gear.

Of course, for the average punter, the idea of replacing and setting up their own router is an anathema on a par with watering the front garden with no clothes on, so they're going to be stuck with whatever the broadband provider hands them anyway. And so, for all the progress Britain has made with broadband speeds, it's going to be choked back by the dismal routers that sit in tens of millions of homes.

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MARCH 2024 Which? Recommended Provider BROADBAND PROVIDERS

Readers' comments

Your views and feedback from email and the web

The internet is rubbish

Jon Honeyball's comments at the end of One Last Thing (*see issue 366, p130*) definitely resonated with me. I have always assumed that 90% of internet information is rubbish (and the resultant training data LOL) and that most people on forums usually post the first thing that comes into their heads without checking anything.

One thing that has changed with Transformer-based AIs is that up to a few years back I could tell fake videos and game screenshots easily – but now I think I may as well hang up my boots as the deluge of AI content drowns everything else out. It has at least made me log out of some of these sites and stay away.

The human condition means that despite telling myself every day for decades not to believe in this rubbish. I still sometimes gullibly sit there taking it in. Face it: there's no way to tell fact from fiction with most of the deluge of information. Meanwhile, I see other people's comments saying this unverified hot air is an alternative to the mainstream press. The BBC might be the best of a bad bunch but at least it can be held accountable for what it publishes. **Neil Walker**

Contributing editor Jon Honeyball replies: Thanks for writing in, Neil. This is why "believe nothing" is now my default position.

ABOVE Don't believe everything you read, or hear, or see, on the internet...

Be nicer to lawyers?

For the past 25+ years I have been enjoying *PC Pro* magazine, and more recently I have listened to and enjoyed the *PC Pro* podcast. However, a disturbing trend on the podcast (and on lesser occasions in the magazine) is to disparage the legal profession. Sometimes such comments are even made when lawyers are present on the podcast panel. I find it bizarre that such comments are made so freely and appear to be acceptable by all panellists on the podcast (and allowed to be printed in the magazine).

The *PC Pro* panel appears to continue to blame many societal problems on lawyers for some reason. It would be nice for the panel to perhaps have a bit of consideration that lawyers are human beings, too, and most are decent, hard-working contributors to society just like most IT professionals. And for the record, I am not a lawyer nor do I have any relatives or good friends who are lawyers. **Maurice Hayek**

Contributing editor Dr Rois Ni Thuama LLB LLM replies: Thanks for thinking of us lawyers, Maurice, but the first rule of presenting a legal argument is to give detailed examples! Especially when claiming to be offended on behalf of others, I always tell objectors they should point to actual instances of offence that can be objectively established. I am a lawyer. And I know that whatever jokes have been delivered in my presence are well aimed. Most of the legal profession are able to take good-natured ribbing, and the courts even expect people to have the "customary phlegm" (or reasonable fortitude) of the ordinary individual. So long as I'm allowed to rib the journalists and IT professionals who are on the *PC Pro* podcast with me, too!

Windows 10 upgrades

With October 2025 fast approaching, I have been trying to update my two Windows 10 laptops to Windows 11. The first is a 17in HP Envy that I use as my daily workstation. Several years ago, I upgraded the mechanical hard disk to a 1TB Crucial SSD, and this provides me with acceptable performance for all the tasks I need to carry out. High on that priority list is using the built-in DVD writer that has ripped my collection of 5,000 CDs to MP3s and, when travelling, serves as a DVD player for my daughter, who has Down's syndrome.

My second laptop is far more portable and is usually used on the sofa for evening searches, emails or listening to my MP3 collection. This is a 12in Toshiba Satellite Radius that boasts a full-size SD card slot on which my MP3s are stored.

The Microsoft Windows 11 Update tool reported no TPM 2 and no Secure Boot on either. So, out came the respective handbooks and, after some frustration and false starts with settings and BIOSes, I finally have both TPM 2 and Secure Boot enabled on both! Success? No. The Windows 11

Star letter

Out of print

I have just read your latest printer test (*see issue 365, p78*) as I always read these religiously in the search of the perfect printer. I have been buying printers since the mid-1990s, with a Canon BJ-30 my first (the only one that stills works, assuming I could buy a new cartridge for it).

I realise it's a difficult thing to measure, but are you able to guess whether a printer will last more than the three or four years I seem to get out of mine? Usually a fixed print head blocks, can't be cleaned and is dearer to replace than to buy a new printer.

I don't think I have overly optimistic expectations. I occasionally print on A3, it will be used maybe once per week, and I don't need it to do other things (I have a perfectly good scanner). So is there one I should buy or can the manufacturer provide parts at a reasonable cost and I am perfectly prepared to repair them? **Richard Parker**

Lee Grant, contributing editor, replies: Fortunately, there's a lot of data on printer longevity and repairability. The Open Repair Alliance (openrepair.org) states that printers last an average of 7.4 years, but the chance of a successful repair is a lowly 39%.

Recently I swapped the print heads on a Canon Pixma. The parts weren't listed by Canon, nor were part numbers published. This evasion is largely due to printers being excluded from Right to Repair legislation.

Unreplaceable print heads remain the biggest cause of failure (and planned obsolescence) that I see. I'm afraid I don't have a simple answer to your question, but before purchasing, ask manufacturers or vendors about replaceable print heads and parts availability as it's valuable information that they won't willingly disclose.

This month's star letter writer wins a Cherry KC 200 MX mechanical keyboard, worth £80, recipient of a five-star review and a *PC Pro* Recommended award. Email letters@pcpro.co.uk

updater acknowledges both these are enabled but now simply states that the processors are “not supported”.

The Toshiba laptop includes an Intel Core 6500U, a 256GB SSD and 8GB of RAM. The HP has the same processor, a 1TB SSD and 12GB of RAM shared with Nvidia graphics. According to Microsoft’s specs, neither of these devices can run Windows 11, but I can buy a “renewed” 14in laptop with a tenth-generation Intel Celeron processor, 4GB of RAM and a 64GB SSD and happily sail off into the Windows 11 sunset. Really?

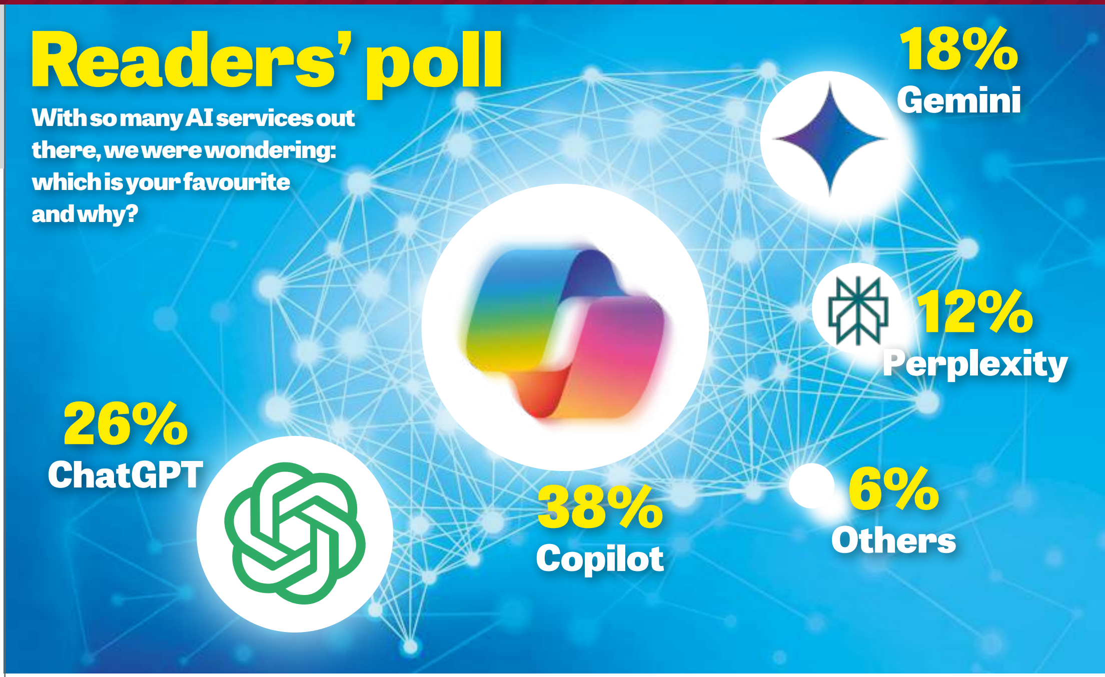
I would welcome your thoughts on whether there is any way to successfully update these devices to Windows 11 or, if not, which Linux distro you would recommend that can still make use of the Nvidia card on my HP – and its DVD writer so it can continue to rip CDs and play DVDs for my daughter. **Chris Moxham**

Linux expert Nik Rawlinson replies:

Installing Linux would be a great way to keep your PC secure if you’re unable to upgrade to Windows 11. I’d recommend live-booting into your preferred distro from a USB drive to check that it works on your hardware and does all you need before committing it to your SSD. Alternatively, partition your internal drive so you can dual boot (back up everything first). Our Labs winner, Ubuntu (*see p78*), supports Nvidia hardware, but we’d recommend checking that you’re running the most appropriate driver. If you go down that route, launch Software & Updates (as distinct from Software Updater), then click Additional Drivers. If it offers up a proprietary driver, select it and click Apply Changes.

Readers’ poll

With so many AI services out there, we were wondering: which is your favourite and why?



Microsoft will be delighted to top our poll of *PC Pro* readers across X and Facebook, especially as it’s just integrated Copilot into Word, Excel and PowerPoint (*see our feature on p26*) for an extra dollop of your cash. And it’s interesting to see the variety of ways Copilot is put to use.

“Copilot on iOS is my most used (second is Copilot on Win11) because it just works as a search engine with answers to questions and provides a list of sources at the bottom,” said @NickLockyer on X. “It sometimes gets it wrong, but you can steer with more prompts.” Pete, @Brainy_Radio, doesn’t have a favourite as “they each have different strengths. I use Copilot for improving my coding [and] Gemini for learning German as its ability to produce example sentences and explain grammar is phenomenal!”

Over on Facebook, ChatGPT proved the most popular. “ChatGPT because it writes programs for my Arduino much better than I can,” said Gordon Jackson.

Dr Peter Moseley (@PeteM2024 on X) bucked the trend by praising Grok, made by Elon Musk’s xAI, but “generally I steer clear of them. I enjoy researching and finding my own answers – I’ve sometimes compared what I’ve found to AI engines and my way is better.”

Peter isn’t our only AI doubter. “I try not to use them,” wrote Carl Waring (@carlwaring). “I don’t want to create visual art or write books. I can compose and play my own music. AI should only be used for things like medical and science research.” Carl, whatever you do, don’t turn to p129 and see what our next Labs is...

> “ChatGPT. I’ve got multiple GPTs set up for different subject matters, absolutely indispensable.”
>
> **Rob Lightbody (@lightbody)**

> “Copilot for generating unit tests for software that I’ve developed.”
>
> **John O’Connell (@endurium)**

> “My favourite AI began and ended with the Babbage Machine.”
>
> **@Ectopoint**

> “Managing fine without using any of them.”
>
> **David Crang**

> “Clippy... I’m nostalgic.”
>
> **Tom Dickson**

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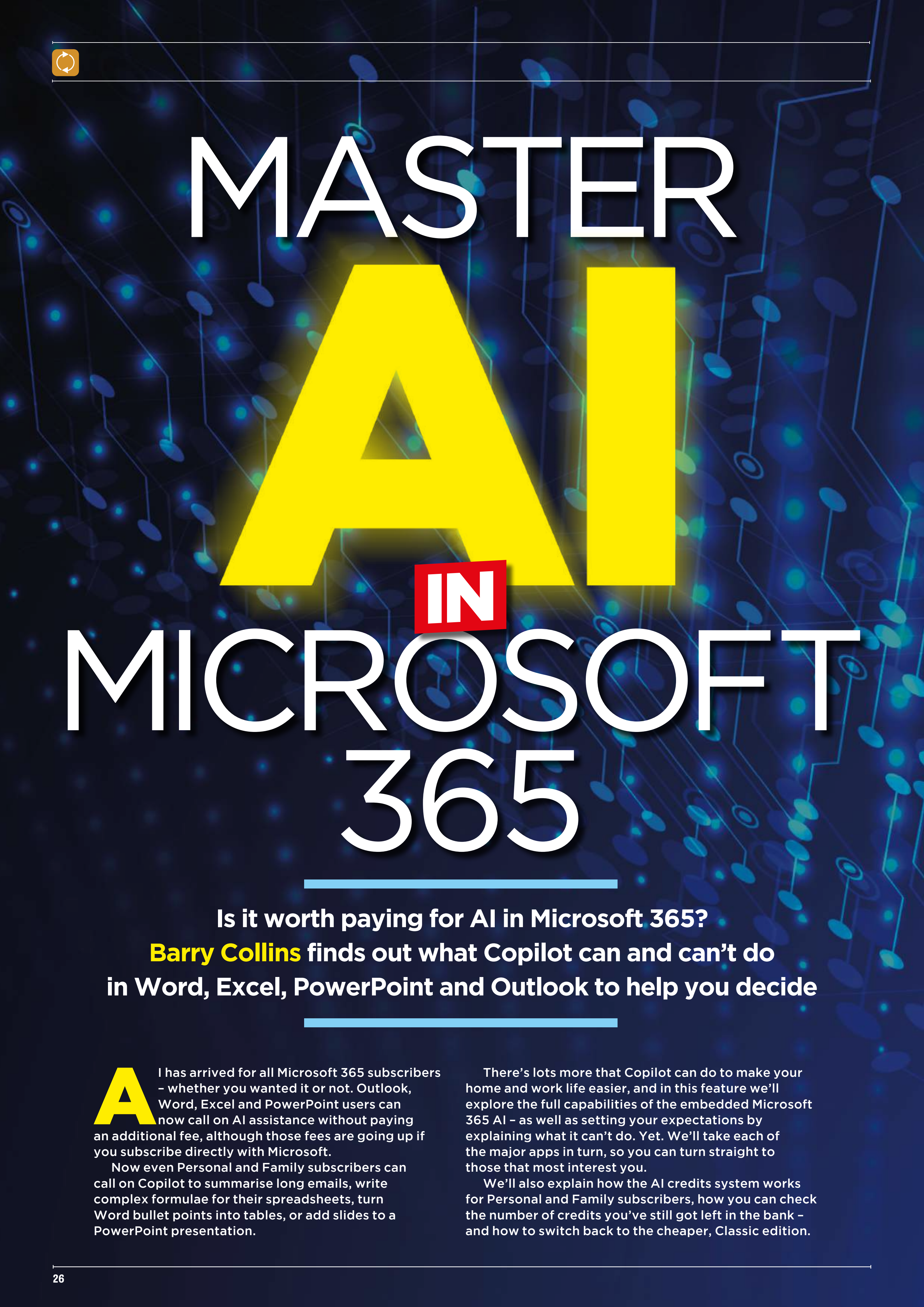

MASTER AI IN MICROSOFT 365

Is it worth paying for AI in Microsoft 365? Barry Collins finds out what Copilot can and can't do in Word, Excel, PowerPoint and Outlook to help you decide

AI has arrived for all Microsoft 365 subscribers – whether you wanted it or not. Outlook, Word, Excel and PowerPoint users can now call on AI assistance without paying an additional fee, although those fees are going up if you subscribe directly with Microsoft.

Now even Personal and Family subscribers can call on Copilot to summarise long emails, write complex formulae for their spreadsheets, turn Word bullet points into tables, or add slides to a PowerPoint presentation.

There's lots more that Copilot can do to make your home and work life easier, and in this feature we'll explore the full capabilities of the embedded Microsoft 365 AI – as well as setting your expectations by explaining what it can't do. Yet. We'll take each of the major apps in turn, so you can turn straight to those that most interest you.

We'll also explain how the AI credits system works for Personal and Family subscribers, how you can check the number of credits you've still got left in the bank – and how to switch back to the cheaper, Classic edition.

AI in Microsoft 365

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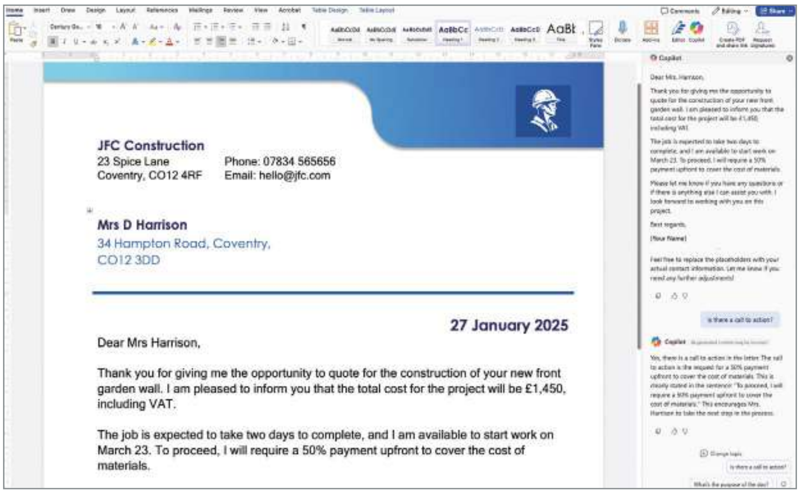
WORD

Microsoft clearly has ambitions for Copilot in Word to become far more than a glorified Clippy, but much work is yet to be done



JFC Construction
23 Spice Lane
Coventry, CO12 4RF

Phone: 07834 565656
Email: hello@jfc.com

Mrs D Harrison
34 Hampton Road, Coventry,
CO12 3DD

27 January 2025

Dear Mrs Harrison,

Thank you for giving me the opportunity to quote for the construction of your new front garden wall. I am pleased to inform you that the total cost for the project will be £1,450, including VAT.

The job is expected to take two days to complete, and I am available to start work on March 23. To proceed, I will require a 50% payment upfront to cover the cost of materials.

RIGHT Copilot is ideal for composing business letters

WHAT CAN IT DO?

Compose business letters

Even though the sophistication of AI writing continues to improve, it's still gobsmackingly obvious when AI has written an entire report or anything of substantial length. However, for jobs such as writing short business letters, the Copilot AI is perfect.

Without wishing to sound condescending, it's ideal for people who struggle with the written word or have a condition such as dyslexia. You can tell the AI what you want the letter to say in telegramese – it doesn't even have to be spelt correctly – and it will compose the letter in a professional tone with no spelling or grammatical errors (any smart arses writing in to tell us we should use it to compose *PC Pro* features will be given the shortest of shrift).

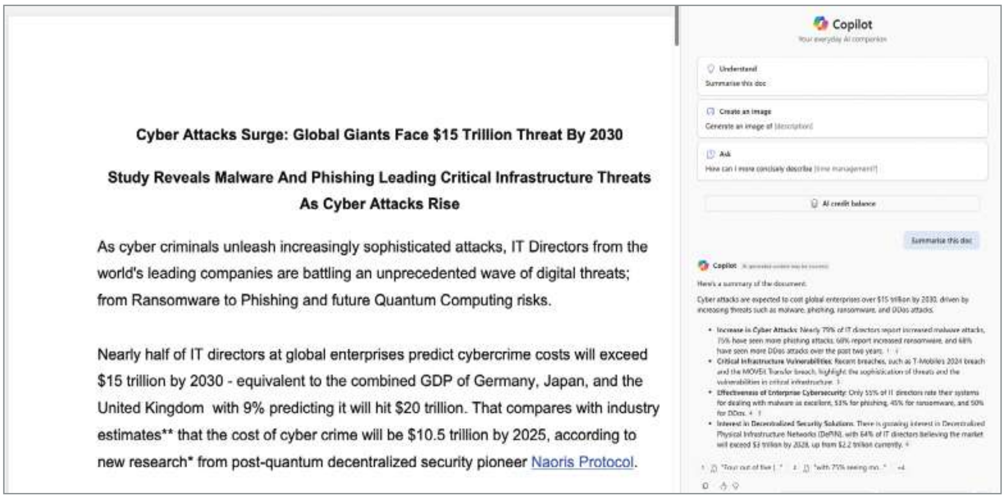
You can generate a draft letter by clicking on the tiny Copilot icon that appears when you start a new line/paragraph, by using the keyboard shortcut ALT+I (Command+/ on a Mac), or by clicking the Copilot button in the Ribbon interface.

Summarising and querying documents

If you frequently find yourself wading through long Word documents trying to find the nuggets of information you need, the Copilot AI could be an enormous timesaver.

The AI is capable of summarising Word docs and even PDFs that have been opened in Word. To do so, hit the Copilot button in the Ribbon interface and you will probably find that "Summarise this doc" is among the default options available at the top of the menu (annoyingly, pressing that button just autofills the prompt window; you then have to press the arrow button or Enter to perform the action). If creating a summary isn't among the defaults, you can simply type the prompt.

A clear advantage of summarising in Word instead of, say, ChatGPT is that Word cites its sources. At the end of each passage there are little numbers that you can click, which are anchor links to the place in the document where that information is contained. It means you can quickly check the AI hasn't invented something or misinterpreted the text.


Copilot
Your everyday AI companion
Understand
Summarise this doc
Create an image
Generate an image of [description]
Ask
How can I more concisely describe [time management]?
AI credit balance
Summarise this doc
Copilot

Cyber Attacks Surge: Global Giants Face $15 Trillion Threat By 2030

Study Reveals Malware And Phishing Leading Critical Infrastructure Threats As Cyber Attacks Rise

As cyber criminals unleash increasingly sophisticated attacks, IT Directors from the world's leading companies are battling an unprecedented wave of digital threats; from Ransomware to Phishing and future Quantum Computing risks.

Nearly half of IT directors at global enterprises predict cybercrime costs will exceed $15 trillion by 2030 - equivalent to the combined GDP of Germany, Japan, and the United Kingdom with 9% predicting it will hit $20 trillion. That compares with industry estimates** that the cost of cyber crime will be $10.5 trillion by 2025, according to new research* from post-quantum decentralized security pioneer Naoris Protocol.

BELOW It's easy to summarise a Word document using AI

You can also ask questions of the document's content. For example, we asked the AI to summarise a press release about a piece of research, and were then able to ask how the research was conducted, saving us from wading down to a footnote on page 5 to discover the survey's methodology.

If the report you're summarising is your own work, you can use the AI's output to create an executive summary of the document.

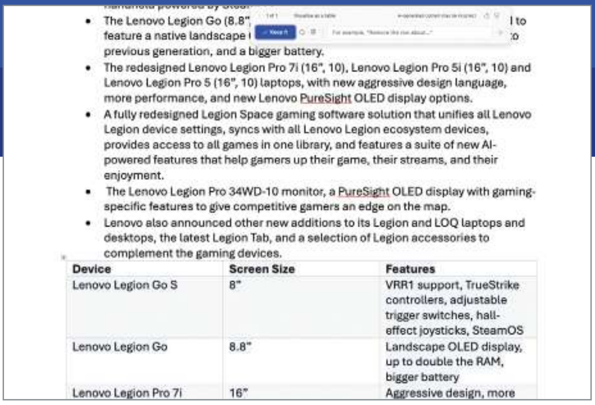
Intelligently reformat content

One of the smarter Copilot options in Word is its ability to reformat content into a table, making information more accessible than it was previously.

In the screenshot at the top left on the opposite page, for example, we've got a list of bullet points from a Lenovo press release, summarising the new products it launched at CES 2025. That information is not easy to take in at a glance. It would definitely be easier to read in table format.

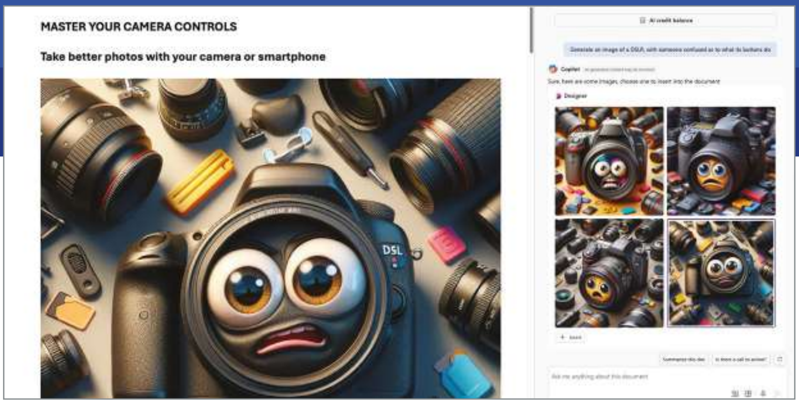
To do this, select the content you want to put into a table, click the Copilot icon that appears alongside the selection and choose "Visualise as a table" in the drop-down menu.

The clever thing here is that Copilot automatically determines the table format, with columns for the device, its screen size and other features. We didn't tell Copilot we wanted these categories; it automatically worked out that product names and screen sizes were a common factor in each of the bullet points and created them by itself. If it picks incorrectly, you can ask it to revise the table in the prompt window that appears after it's created a table.



- The Lenovo Legion Go (8.8" … l to feature a native landscape … o previous generation, and a bigger battery.
- The redesigned Lenovo Legion Pro 7i (16", 10), Lenovo Legion Pro 5i (16", 10) and Lenovo Legion Pro 5 (16", 10) laptops, with new aggressive design language, more performance, and new Lenovo PureSight OLED display options.
- A fully redesigned Legion Space gaming software solution that unifies all Lenovo Legion device settings, syncs with all Lenovo Legion ecosystem devices, provides access to all games in one library, and features a suite of new AI-powered features that help gamers up their game, their streams, and their enjoyment.
- The Lenovo Legion Pro 34WD-10 monitor, a PureSight OLED display with gaming-specific features to give competitive gamers an edge on the map.
- Lenovo also announced other new additions to its Legion and LOQ laptops and desktops, the latest Legion Tab, and a selection of Legion accessories to complement the gaming devices.

Device	Screen Size	Features
Lenovo Legion Go S	8"	VRR1 support, TrueStrike controllers, adjustable trigger switches, hall-effect joysticks, SteamOS
Lenovo Legion Go	8.8"	Landscape OLED display, up to double the RAM, bigger battery
Lenovo Legion Pro 7i	16"	Aggressive design, more



MASTER YOUR CAMERA CONTROLS

Take better photos with your camera or smartphone

Not everything is spot on. We're not sure "aggressive design" is really a feature as such, but it's done a decent job of making dense information more readable.

Generate images

The DALLE image generator is available within Word, meaning that instead of scraping images off the internet (with its associated copyright infringement risks) or trying to find something in a stock library, you can have the AI knock something up.

In the screenshot above right, we're writing a piece on how to master your camera controls on a DSLR, so we want an image to accompany it. We ask Copilot to "generate an image of a DSLR, with someone confused as to what its buttons do", and though the result isn't exactly what we asked for and there are clear signs the image is AI-generated, it's usable – particularly with a little photo editing.

Under the generated images, Word has an Insert button, which you would hope would insert the image where the cursor appears in the document. Alas, it popped it at the top of the document in our tests, which is inconvenient and indicates that there is still development work to be done.

Dictate and tidy up

If you're rushing between meetings in the back of a taxi, say, sometimes you just need to get something down quickly. The Microsoft 365 Copilot mobile app lets you dictate text, and the accuracy of the transcription is remarkably decent. However, errors do creep in and the format of your dictated text is unlikely to be bang on. But you can use Copilot to clean it up.

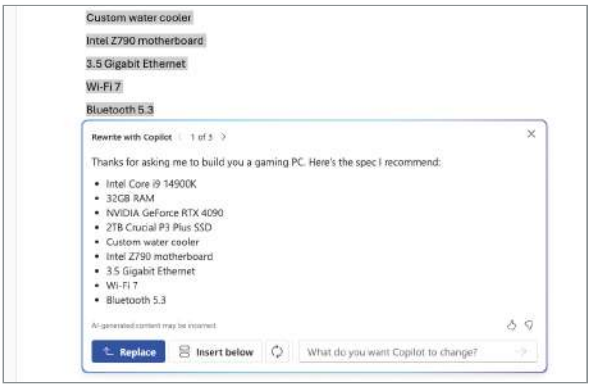
In the screenshot below left, for example, we gave it a pretty stiff test, dictating the spec of a gaming PC that a customer had asked us to build. As you can see, the initial transcription wasn't at all bad, but it struggled with the format of the tech specs, spelling out gigabytes and misformatting the Nvidia GeForce brand.

We saved the dictated document in OneDrive, opened it in the Word web app, highlighted the dictated text and asked Copilot to rewrite it. It made a stand-up job of sorting out all the formatting errors and – aside from a slight snafu where the dictation heard "3.5Gb Ethernet" instead of "2.5Gb Ethernet" – it's almost ready to send.

ABOVE Copilot created a table summarising the contents of this press release

ABOVE RIGHT Images are created with the help of DALLE, but they'll look AI-generated

BELOW You can use Copilot to clean up dictated text



Custom water cooler

Intel Z790 motherboard

3.5 Gigabit Ethernet

Wi-Fi 7

Bluetooth 5.3

Thanks for asking me to build you a gaming PC. Here's the spec I recommend:

- Intel Core i9 14900K
- 32GB RAM
- NVIDIA GeForce RTX 4090
- 2TB Crucial P3 Plus SSD
- Custom water cooler
- Intel Z790 motherboard
- 3.5 Gigabit Ethernet
- Wi-Fi 7
- Bluetooth 5.3

AI-generated content may be incorrect

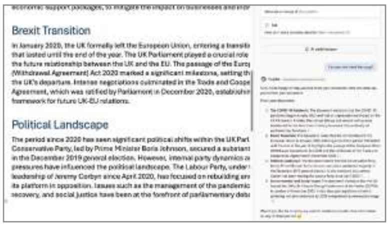
WHAT CAN'T IT DO?

Factual corrections

Relying on AI to fact-check anything is a risky business, but Copilot in Word really seems to struggle with the task. We asked the AI to generate a 400-word history of the UK parliament since 2020, which seemed largely fine. We then introduced two errors: replacing Keir Starmer with Jeremy Corbyn as the leader of the Labour Party since 2020, and relocating the COP26 from Glasgow to London.

We then asked Copilot to fact-check the copy, but it simply repeated a list of facts from the article, including incorrect ones. We changed the prompt to "Can you check the factual claims in the document are true?" just to make sure it wasn't confused by the term "fact-check", but it repeated the same answer. Only when we asked it if it had found any errors did it finally highlight the Corbyn and London gaffes. When we asked it to correct the errors, it simply repeated them back to us.

When we cut and pasted the copy into ChatGPT and asked it to fact-check the document, it highlighted both the Labour leader and COP26 errors first time, as well as confirming other facts were true. It was also happy to correct the copy.



Brexit Transition

In January 2020, the UK formally left the European Union, entering a transiti… that lasted until the end of the year. The UK Parliament played a crucial role … the future relationship between the UK and the EU. The passage of the Euro… (Withdrawal Agreement) Act 2020 marked a significant milestone, setting th… the UK's departure. Intense negotiations culminated in the Trade and Coope… Agreement, which was ratified by Parliament in December 2020, establishin… framework for future UK-EU relations.

Political Landscape

The period since 2020 has seen significant political shifts within the UK Parl… Conservative Party, led by Prime Minister Boris Johnson, secured a substant… in the December 2019 general election. However, internal party dynamics a… pressures have influenced the political landscape. The Labour Party, under … leadership of Jeremy Corbyn since April 2020, has focused on rebuilding an… its platform in opposition. Issues such as the management of the pandemic… recovery, and social justice have been at the forefront of parliamentary deba…

ABOVE Don't rely on Copilot to fact-check your documents

It may be that you simply need to be much more precise with the prompt in Copilot than you do with ChatGPT, but given that they're both based on the same technology, the discrepancy is odd – and a little worrying.

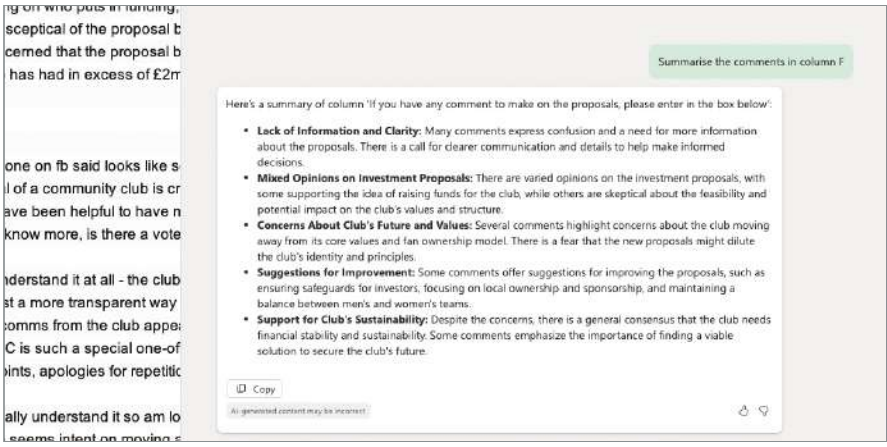
Improve document appearance

Copilot (in its current guise, at least) seems incapable of physically changing the appearance of your documents. When we asked the AI "Can you make this document look more attractive?" it dashed off a boilerplate list of ways to make documents easier on the eye, such as consistent fonts and a cohesive colour scheme, but it didn't attempt to tweak the design itself. Indeed, the advice it offered didn't appear to be the least bit tailored to the document on the screen, which was already using consistent fonts and headers/subheaders as the AI suggested.

It was a similar story when we asked how we could add a watermark to our document. When we entered the prompt, we could see Copilot reporting that it was "searching the web" for ways to add a watermark in Word for Mac, which is bizarre. You'd have thought basic Word features such as this would have been added to the AI's training data and not left to chance with an online search. The answer was correct, but we had to do it manually, the AI couldn't add a watermark on our behalf.

EXCEL

Excel is where Copilot can make a genuine difference to your workflow, and we recommend you take advantage


ig on who puts in funding,
sceptical of the proposal b
cerned that the proposal b
has had in excess of £2m
one on fb said looks like s
l of a community club is cr
ave been helpful to have m
know more, is there a vote
nderstand it at all - the club
st a more transparent way
comms from the club appe
C is such a special one-of
oints, apologies for repetitio
ally understand it so am lo
seems intent on moving
Copy
AI-generated content may be incorrect

Summarise the comments in column F

Here's a summary of column 'If you have any comment to make on the proposals, please enter in the box below':

- **Lack of Information and Clarity:** Many comments express confusion and a need for more information about the proposals. There is a call for clearer communication and details to help make informed decisions.
- **Mixed Opinions on Investment Proposals:** There are varied opinions on the investment proposals, with some supporting the idea of raising funds for the club, while others are skeptical about the feasibility and potential impact on the club's values and structure.
- **Concerns About Club's Future and Values:** Several comments highlight concerns about the club moving away from its core values and fan ownership model. There is a fear that the new proposals might dilute the club's identity and principles.
- **Suggestions for Improvement:** Some comments offer suggestions for improving the proposals, such as ensuring safeguards for investors, focusing on local ownership and sponsorship, and maintaining a balance between men's and women's teams.
- **Support for Club's Sustainability:** Despite the concerns, there is a general consensus that the club needs financial stability and sustainability. Some comments emphasize the importance of finding a viable solution to secure the club's future.

RIGHT AI is great for analysing qualitative data

WHAT CAN I DO?

✓ Collate survey feedback

Excel is, of course, right at home when it comes to the analysis of quantitative data. Qualitative data? Not so much. At least, not until Copilot reared its head and made the job easier.

Let's say you've published an online survey or a customer feedback form that contains a field allowing respondents to write comments – something we do in the annual *PC Pro* Excellence Awards survey, where we invite you to share your experiences of the companies you've bought kit and services from.

You may end up with hundreds or thousands of free-form comments in an Excel spreadsheet column that, until now, you would basically have to wade through manually, trying to detect themes. Now the AI can do that laborious job for you in seconds.

Fire up Copilot and ask it to "summarise the comments in column F" or wherever the data is stored, and it will give you a bullet-pointed summary of the common themes from the feedback. You may want to do a more in-depth manual analysis later, but if you just want the headline trends, it's a cracking shortcut.

✓ Create data dashboards

We've created some fictional data (using ChatGPT, since you ask) for a car dealership, showing sales for the past couple of years. The spreadsheet shows the date of sale, brand, model, region, quantity sold, price per unit and total sales.

There's obviously a lot we can do with this data, various ways we can manipulate it, but you can also ask Copilot to suggest ways in which the data can be analysed. When we click the Copilot button, one of the default options is "show data insights", so we give that a spin, and the first insight it delivers is to break down sales by region – a metric that you'd almost certainly want to measure.

Now a button appears labelled "Add all insights to grid", and it effectively creates a data dashboard on a separate sheet, showing various graphs. To be honest, a few of them are sheer twaddle, but there are a couple of useful ones here showing the type of data you might want, such as in which region the Tesla brand has recorded the most sales. These are PivotCharts created without having to know how to do them or even what they are.

Annoyingly, when we ask Copilot to add different insights to the grid it baulks, merely providing instructions on how to do it manually.

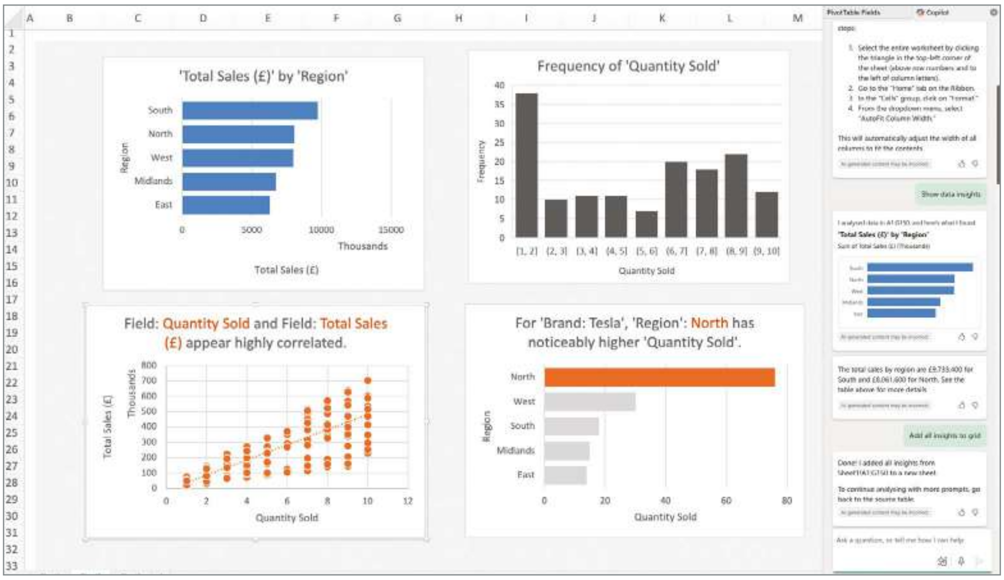
✓ Conditional formatting

Copilot can also be of assistance when it comes to conditional formatting – highlighting items that meet certain criteria.

Let's go back to our car sales data. Let's say we want to highlight any single transaction where we sold more than £500,000 worth of cars in one hit, because that qualifies the salesperson for a bonus. We don't have to fiddle with formulae or the conditional formatting tools – we can ask Copilot to do it on our behalf.

We enter the prompt "highlight in yellow any row where total sales exceeds £500,000". Copilot spends a few seconds thinking about it, comes up with a formula that can be applied to the sheet, and then offers a button from which we can apply the formula. When we hit that, every row with a total sales value exceeding half a million is highlighted.

Interestingly, this didn't work when we tried it on Excel for Mac – it only worked in the Windows version. We'd watched a video of someone doing this in Excel, so we knew it was possible, and that means (not for the first time) that the Mac version of Excel isn't as fully featured as the Windows version. As we'll see again below…


A
B
C
D
E
F
G
H
I
J
K
L
M
'Total Sales (£)' by 'Region'
South
North
West
Midlands
East
Region
0
5000
10000
15000
Thousands
Total Sales (£)
Frequency of 'Quantity Sold'
40
35
30
25
20
15
10
5
0
Frequency
[1, 2]
[2, 3]
[3, 4]
[4, 5]
[5, 6]
[6, 7]
[7, 8]
[8, 9]
[9, 10]
Quantity Sold
Field: Quantity Sold and Field: Total Sales (£) appear highly correlated.
800
700
600
500
400
300
200
100
0
Thousands
Total Sales (£)
0
2
4
6
8
10
12
Quantity Sold
For 'Brand: Tesla', 'Region': North has noticeably higher 'Quantity Sold'.
North
West
South
Midlands
East
Region
0
20
40
60
80
Quantity Sold
PivotTable Fields
Copilot
Show data insights
Add all insights to grid
Ask a question, or tell me how I can help

steps:

1. Select the entire worksheet by clicking the triangle in the top-left corner of the sheet (above row numbers and to the left of column letters).
2. Go to the "Home" tab on the Ribbon.
3. In the "Cells" group, click on "Format".
4. From the dropdown menu, select "AutoFit Column Width."

This will automatically adjust the width of all columns to fit the contents.

I analysed data in A1:G150, and here's what I found:

'Total Sales (£)' by 'Region'

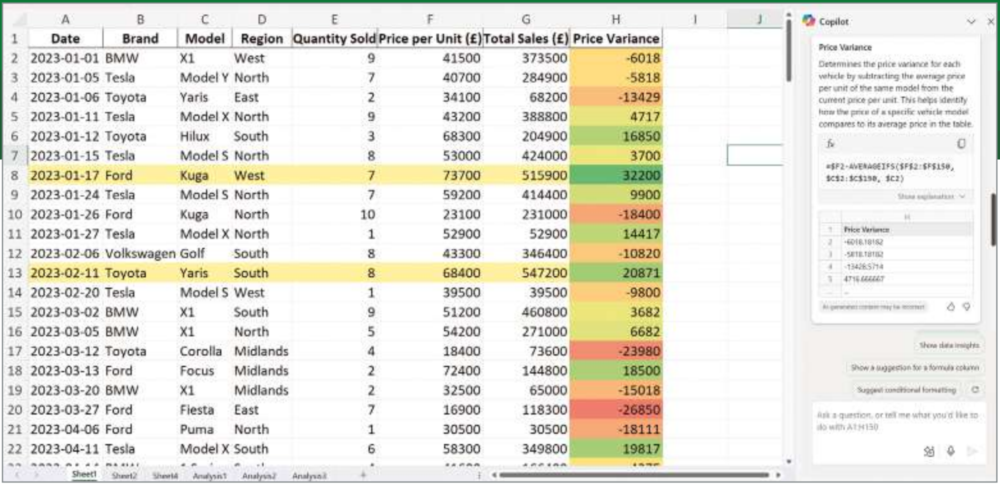
Sum of Total Sales (£) (Thousands)

The total sales by region are £8,735,400 for South and £8,061,600 for North. See the table above for more details.

Done! I added all insights from Sheet1!A1:G150 to a new sheet.

To continue analysing with more prompts, go back to the source table.

BELOW Copilot can automatically create PivotCharts from your data



	A	B	C	D	E	F	G	H
1	Date	Brand	Model	Region	Quantity Sold	Price per Unit (£)	Total Sales (£)	Price Variance
2	2023-01-01	BMW	X1	West	9	41500	373500	-6018
3	2023-01-05	Tesla	Model Y	North	7	40700	284900	-5818
4	2023-01-06	Toyota	Yaris	East	2	34100	68200	-13429
5	2023-01-11	Tesla	Model X	North	9	43200	388800	4717
6	2023-01-12	Toyota	Hilux	South	3	68300	204900	16850
7	2023-01-15	Tesla	Model S	North	8	53000	424000	3700
8	2023-01-17	Ford	Kuga	West	7	73700	515900	32200
9	2023-01-24	Tesla	Model S	North	7	59200	414400	9900
10	2023-01-26	Ford	Kuga	North	10	23100	231000	-18400
11	2023-01-27	Tesla	Model X	North	1	52900	52900	14417
12	2023-02-06	Volkswagen	Golf	South	8	43300	346400	-10820
13	2023-02-11	Toyota	Yaris	South	8	68400	547200	20871
14	2023-02-20	Tesla	Model S	West	1	39500	39500	-9800
15	2023-03-02	BMW	X1	South	9	51200	460800	3682
16	2023-03-05	BMW	X1	North	5	54200	271000	6682
17	2023-03-12	Toyota	Corolla	Midlands	4	18400	73600	-23980
18	2023-03-13	Ford	Focus	Midlands	2	72400	144800	18500
19	2023-03-20	BMW	X1	Midlands	2	32500	65000	-15018
20	2023-03-27	Ford	Fiesta	East	7	16900	118300	-26850
21	2023-04-06	Ford	Puma	North	1	30500	30500	-18111
22	2023-04-11	Tesla	Model X	South	6	58300	349800	19817

Price Variance

Determines the price variance for each vehicle by subtracting the average price per unit of the same model from the current price per unit. This helps identify how the price of a specific vehicle model compares to its average price in the table.

```
=$F2-AVERAGEIFS($F$2:$F$150,
$C$2:$C$150, $C2)
```

	H
1	Price Variance
2	-6018.18182
3	-5818.18182
4	-13428.5714
5	4716.666667

AI-generated content may be incorrect

Show explanation
Show data insights
Show a suggestion for a formula column
Suggest conditional formatting
Ask a question, or tell me what you'd like to do with A1:H150

✓ Avoid formulae

Many Excel users would turn into a puddle on their office chair if asked to create complicated formulae. Copilot can avoid the embarrassment.

Let's take our car sales sheet again. It lists the price per unit of each model sold, but that's not a set price. For example, the first batch of BMW X1 cars sold is for £41,500 per unit, the next lot is £51,200 per unit. So it would be helpful to know how much each sale is above/below the average unit price for that particular model. However, writing that formula would, we suspect, be beyond a large proportion of Excel users.

We ask Copilot to "create a column that shows how much the price per unit for that sale varies from the average price per unit of that model". It does the hard work, comes up with the necessary formula and explains its workings, so that even if you're not confident of understanding the formula yourself, you can be reasonably confident it understood what you asked.

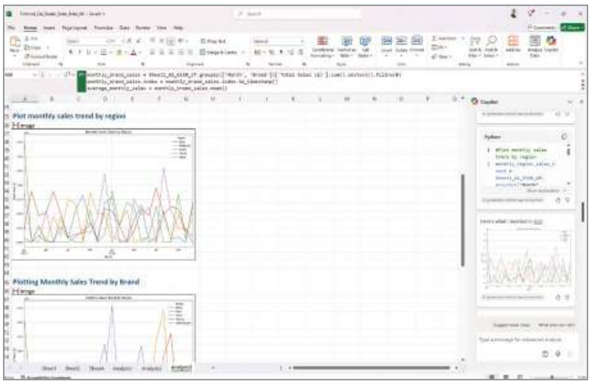
Another button press applies the formula to a new column, and now we have the price variance for each sale on our spreadsheet.

How to check your AI credits

If you're using a Personal or Family subscription for Microsoft 365, you'll get 60 AI credits per month. You'll burn through one credit for each prompt. It doesn't matter if the prompt generates an entire PowerPoint presentation or gives you a one-word answer to a question; each prompt is equal to one credit.

You can check how many credits you've got left by opening any Microsoft 365 app, opening Copilot and clicking the link to check your AI credits. Alternatively, you can visit account.microsoft.com and you should see your remaining credits for the month listed there.

If you run out of credits, there's the option to get effectively unlimited credits by signing up to Microsoft Copilot Pro for £19 per month. You should be offered the first month free, and there's no obligation to maintain the subscription beyond that initial month's trial.



Plot monthly sales trend by region
Plotting Monthly Sales Trend by Brand

TOP You don't have to fiddle around with conditional formatting

ABOVE You can use Python for advanced analysis of your data

You could of course apply conditional formatting to highlight the sales with the biggest variances.

✓ Advanced analysis with Python

The ability to manipulate data with the Python programming language was recently added to Excel, and Copilot works with it too – as long as you're using the Windows version of Excel. It's not supported on Mac (yet).

When we opened our car sales sheet in Windows and clicked on the Copilot icon in the Ribbon, we were given the option of advanced analysis using Python. When we clicked on that, Copilot created a new "Analysis" sheet in the workbook, and then asked us what kind of analysis we were looking for, as well as coming up with a couple of suggestions of its own.

For instance, it suggested we "investigate monthly sales trends to identify any seasonal patterns", and then set about plotting overall sales across the timeline of our data. Then it suggested we plot each region's monthly sales trend to see if there were any patterns we could detect there.

For each plot, Copilot wrote the necessary Python code and then added it to the sheet. You can click a little [PY] icon above each graph to access the code. You can then edit the code yourself if you know your way around the programming language.

WHAT CAN'T IT DO?

☒ Work on local-only files

If you want to use Copilot on Excel files, Microsoft demands that you have autosaves turned on and that the file is synced with your OneDrive account. It's not clear why – it doesn't make such demands for Word documents, for example.

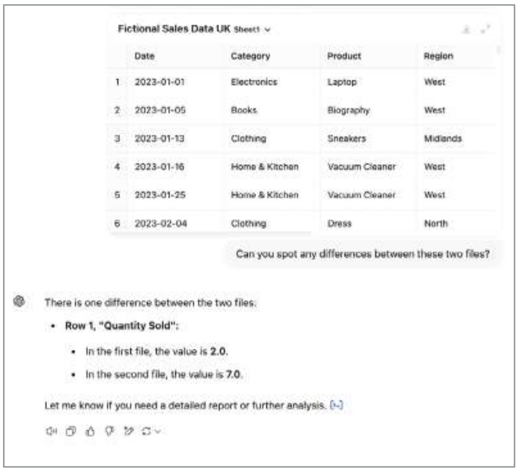
That could be a showstopper for some. Excel documents are probably the most likely of all the Microsoft 365 file types to contain sensitive data, and you may not want that loitering in Microsoft's cloud or being shoved through an AI system in the first place.

In Microsoft's defence, it's no worse than using ChatGPT or any other cloud-based LLM. But it's no better, either.

☒ Compare worksheets

Unlike ChatGPT or other cloud-based services, Excel doesn't allow you to compare data between two (or more) different workbooks. The AI can only work with the workbook you've got open at the time. It can compare data between different sheets in the same workbook, but not entirely separate files.

There's nothing to stop you comparing sheets in the Copilot app built into Windows, but it does seem a little odd that you can't do so within the Excel app itself.



Fictional Sales Data UK Sheet1

	Date	Category	Product	Region
1	2023-01-01	Electronics	Laptop	West
2	2023-01-05	Books	Biography	West
3	2023-01-13	Clothing	Sneakers	Midlands
4	2023-01-16	Home & Kitchen	Vacuum Cleaner	West
5	2023-01-25	Home & Kitchen	Vacuum Cleaner	West
6	2023-02-04	Clothing	Dress	North

Can you spot any differences between these two files?

There is one difference between the two files:

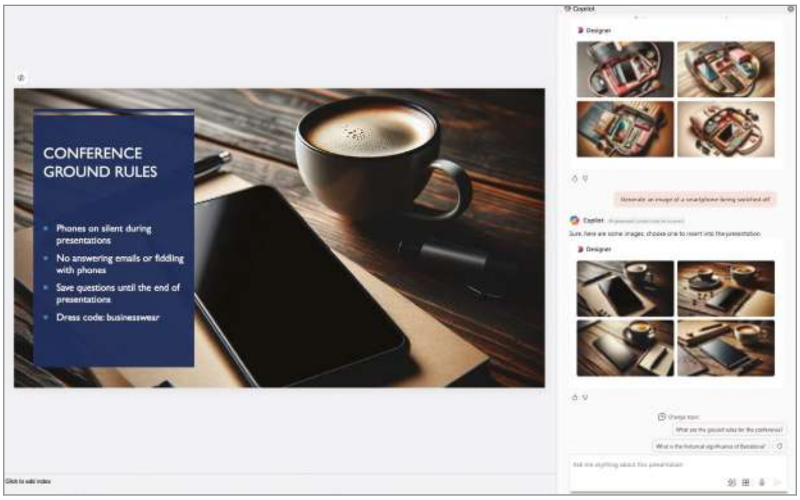
- **Row 1, "Quantity Sold":**
  - In the first file, the value is **2.0**.
  - In the second file, the value is **7.0**.

Let me know if you need a detailed report or further analysis.

RIGHT You can't compare data between workbooks

POWERPOINT

Used wisely, Copilot not only saves you time when creating PowerPoint presentations but also gives them greater impact


CONFERENCE GROUND RULES

- Phones on silent during presentations
- No answering emails or fiddling with phones
- Save questions until the end of presentations
- Dress code: businesswear

RIGHT Copilot will find copyright-free images with the correct prompt

WHAT CAN IT DO?

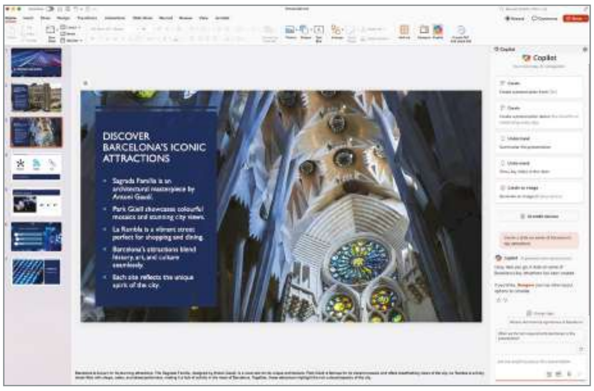
✓ Generate slides (or even whole presentations)

While the capability of generating an entire presentation from a single prompt sounds impressive, we can't think of any scenario – bar pure desperation – where you would. There are endless YouTube videos of people gleefully typing in "generate a presentation about global warming" or some such, and while the results generally look nice, the content is as bland and beige as a Marks & Spencer cardigan. What purpose does it serve?

There are situations, however, where relying on Copilot to generate a slide or two makes sense. Let's say, for example, you're putting together a presentation about a company conference in Barcelona. You might ask the AI to generate a slide highlighting some of the city's key attractions for attendees who have never been there before. The AI also generates or picks stock images to accompany your slide, as you can see from our screenshot below.

You can tell the AI what you want the content of the slide to be, too. We ran a prompt that said: "Add a slide outlining the conference schedule. It will start at 9am-5pm in the Gaudi Hotel on Monday 10th March. Tuesday morning is for breakout sessions. Tuesday afternoon is for networking. Wednesday morning is free time. Wednesday PM is flights home."

Copilot automatically distilled the information into bullet points on a slide and found a suitable conference room picture to accompany it. One of the alternative slide designs, found by clicking Designer in the Ribbon, also included little icons to go with each bullet, such as a pilot graphic for the flights home. It's nice touches such as this that can speed up the creation of slides. The content is editable, too, so if it omits something key or dreams up a fact, you can easily amend.


DISCOVER BARCELONA'S ICONIC ATTRACTIONS

- Sagrada Família is an architectural masterpiece by Antoni Gaudí.
- Park Güell showcases colourful mosaics and stunning city views.
- La Rambla is a vibrant street perfect for shopping and dining.
- Barcelona's attractions blend history, art, and culture seamlessly.
- Each site reflects the unique spirit of the city.

BELOW The AI can generate images to accompany your PowerPoint slides

✓ Generate images

If you're going to bore people to death with a PowerPoint presentation, the very least you can do is provide them with some eye candy. But trying to find (copyright-free) images to add to presentations is often a chore.

Copilot AI lets you generate images that it might otherwise be a struggle to find. For example, we wanted an image to accompany the "ground rules" slide for our business conference in Barcelona (switch off smartphones and so on). We asked the AI to generate an image of a smartphone switched off, and cleverly it generated four images that looked like a switched-off phone on a business conference desk, building in the context of the overall presentation while generating the image.

Just click to insert the image of your choice or ask it to regenerate images (perhaps with a tweaked prompt) if it doesn't get it right first time.

✓ Anticipate audience questions

You've spent hours polishing a sales pitch slide deck and you're ready to face potential clients. Inevitably, you'll be expecting to answer their questions at the end of the pitch, but what might they want to know? You can ask Copilot to "suggest questions the audience may ask about this presentation" and it will come up with half a dozen or more different questions that you might face.

Some of them will probably be insultingly obvious, but it might just find a question or two that you hadn't predicted, allowing you to be better prepared when you're doing it for real, rather than floundering for words like an *Apprentice* contestant.

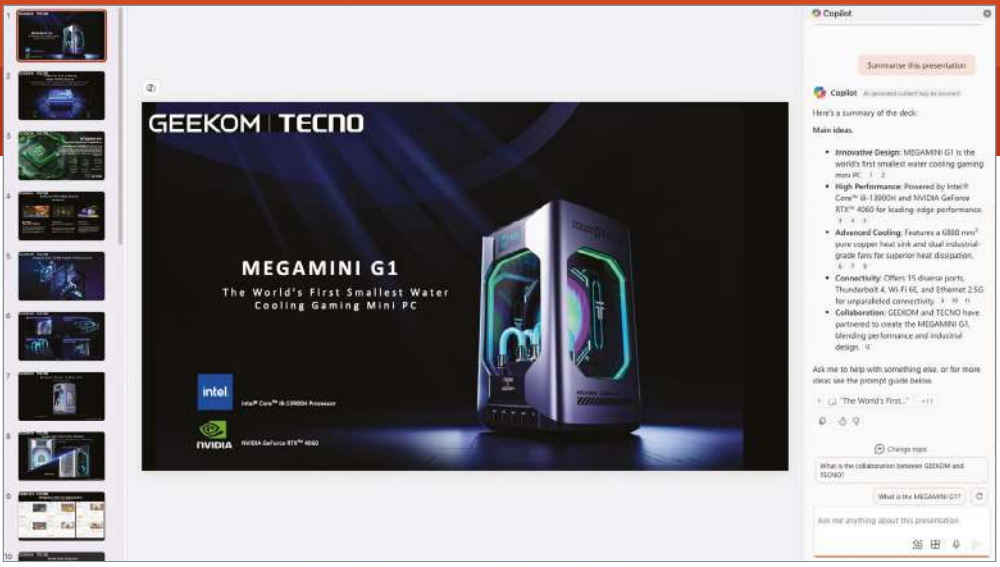
How to switch back to Microsoft 365 Classic

If the AI leaves you completely cold and you just want to return to how it was – without paying extra – you can. But Microsoft doesn't make it easy.

This option only applies if you buy your subscription directly from Microsoft. It allows customers to revert to what Microsoft is calling its Classic plan, which drops prices to previous levels and omits AI features – but "only for a limited period".

Microsoft isn't making it easy to switch, either. Don't click on the option to Switch Plan in your Microsoft account settings – that would far too sensible. Instead:

1. **Go to office.com/myaccount**
2. **In the left-hand menu, click Subscriptions**
3. **Subscription details will be shown; click Manage**
4. **Click "Cancel Subscription"**
5. **Select required Classic option**


GEEKOM | TECNO
MEGAMINI G1
The World's First Smallest Water Cooling Gaming Mini PC
intel
Intel® Core™ i9-13900H Processor
NVIDIA
NVIDIA GeForce RTX™ 4060
Copilot

Summarise this presentation

Copilot

Here's a summary of the deck:

Main ideas:

- **Innovative Design:** MEGAMINI G1 is the world's first smallest water cooling gaming mini PC. 1 2
- **High Performance:** Powered by Intel® Core™ i9-13900H and NVIDIA GeForce RTX™ 4060 for leading-edge performance. 3 4 5
- **Advanced Cooling:** Features a 6880 mm² pure copper heat sink and dual industrial-grade fans for superior heat dissipation. 6 7 8
- **Connectivity:** Offers 15 diverse ports, Thunderbolt 4, Wi-Fi 6E, and Ethernet 2.5G for unparalleled connectivity. 9 10 11
- **Collaboration:** GEEKOM and TECNO have partnered to create the MEGAMINI G1, blending performance and industrial design. 12

Ask me to help with something else, or for more ideas see the prompt guide below.

1 "The World's First..." +11

Change topic

What is the collaboration between GEEKOM and TECNO?

What is the MEGAMINI G1?

Ask me anything about this presentation

ABOVE Copilot can take the strain out of any slide decks you're sent

Summarise presentations

The post-Covid demise of real-life meetings means you're often sent a slide deck instead of seeing it laboriously presented in person. Around these parts, it's not unusual for us to be sent 20, 30 or 40-slide decks about new product launches, for instance, and it can be an enormous chore even skimming them.

Copilot can take some of that strain with its ability to summarise slide decks opened in PowerPoint. Just ask it to "summarise this presentation" – it's one of the default options when you press the Copilot icon – and you'll get a bulleted precis of its contents. If it's a presentation that's been sent unsolicited, that might be enough to decide whether it merits further attention or not.

There's also an option to "show key slides in this deck", although that merely presents you with a list of the slides it deems important, with links to jump straight to them. We found this highly erratic in testing, with the AI often choosing borderline irrelevant slides.

Answer questions about slide content

If you know there's a specific piece of information buried in a slide deck somewhere and can't be bothered to wade through the entire presentation to find it, you can ask the AI questions about the presentation.

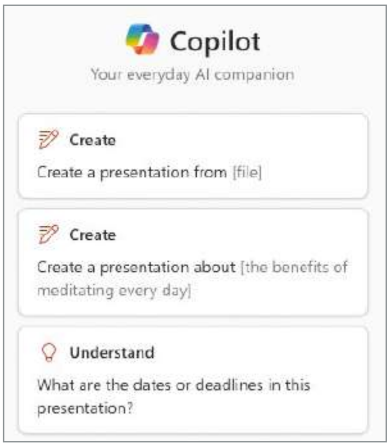
Schools, for example, are legendary for sending out massive slide decks with information about trips, and trying to find key details can be a challenge. However, with PowerPoint, you can open the deck, fire up Copilot and ask for key information such as "what time do the children return from the trip?"

Copilot provides a link in the answer to the slide from where it gleaned the information, so you can double-check it's not hallucinating.

WHAT CAN'T IT DO?

Create a presentation from files (despite offering to do so!)

One of the first things Copilot offers to do when you open PowerPoint is to create a presentation from a file. The idea is that if you have, say, a sales pitch already encapsulated in a Word document or a PDF, you can save time by getting the AI to automatically create a presentation from those materials, which sounds like an absolutely smashing timesaver. Except it doesn't work, at least not in our tests on three different PCs/Macs.



Create a presentation from [file]

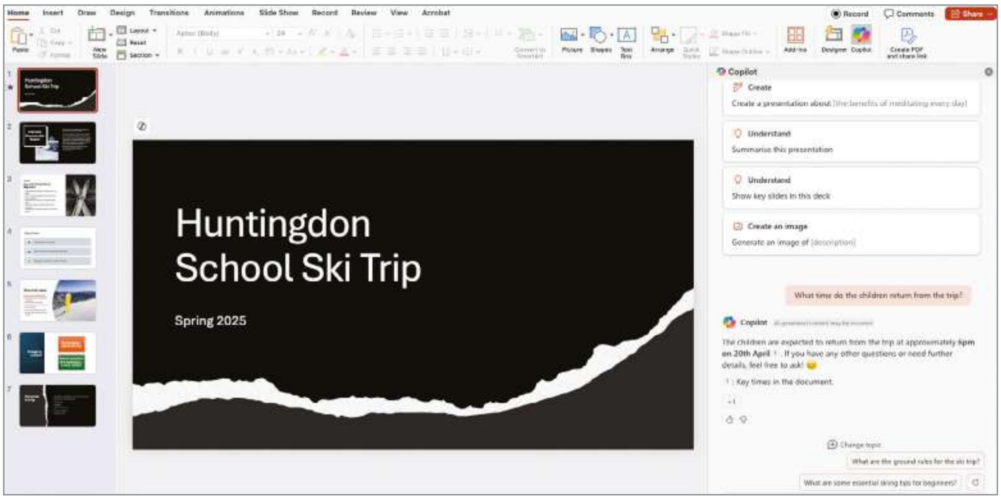
Create a presentation about [the benefits of meditating every day]

What are the dates or deadlines in this presentation?

RIGHT Want Copilot to create a presentation? You're out of luck

When you hit the option to create a presentation from a file, there's no pop-up window inviting you to pick a file from Explorer. The prompt just sits there. Even if you try to manually insert the file path of the file after the prompt, you get a snarky warning saying the file must be in your personal OneDrive – even if the file path you've pasted in is for a file that's already in your personal OneDrive.

This feature definitely exists, because there are YouTube videos of real customers using it. However, it looks like something that Microsoft offers to business Copilot customers that it's either forgotten to remove for consumers or hasn't properly enabled. It's indicative of the rushed, slightly haphazard way that Microsoft has implemented Copilot features.



Create a presentation about [the benefits of meditating every day]

Summarise this presentation

Show key slides in this deck

Generate an image of [description]

What time do the children return from the trip?

Copilot

The children are expected to return from the trip at approximately **6pm on 20th April** 1. If you have any other questions or need further details, feel free to ask! 😊

1 : Key times in the document.

Change topic

What are the ground rules for the ski trip?

What are some essential skiing tips for beginners?

BELOW Extracting important info from a huge slide deck is simple

Add transitions or other effects

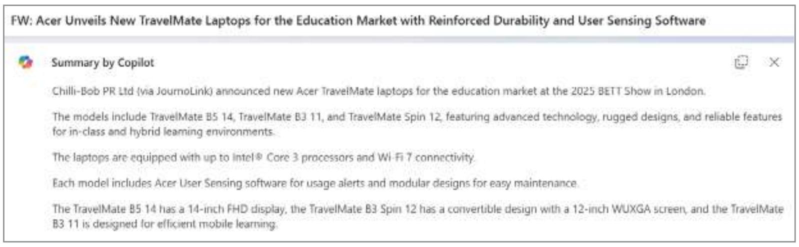
You'd think one of the fundamentals for PowerPoint would be the option to simply ask Copilot to add frills such as transitions to your slides, without having to manually find the feature in the menus.

However, Copilot practically goes on strike when you ask it to perform this rudimentary task. When we prompted Copilot to "add sliding transitions between the slides in this deck", it replied curtly with, "I'm sorry I can't do that". You don't even get text instructions on how to do it yourself. Baffling.

➔

OUTLOOK

A missed opportunity in many ways, not least due to its lack of support for non-Microsoft services, but some people will find it a handy tool



FW: Acer Unveils New TravelMate Laptops for the Education Market with Reinforced Durability and User Sensing Software

Summary by Copilot

Chilli-Bob PR Ltd (via JournoLink) announced new Acer TravelMate laptops for the education market at the 2025 BETT Show in London.

The models include TravelMate B5 14, TravelMate B3 11, and TravelMate Spin 12, featuring advanced technology, rugged designs, and reliable features for in-class and hybrid learning environments.

The laptops are equipped with up to Intel® Core 3 processors and Wi-Fi 7 connectivity.

Each model includes Acer User Sensing software for usage alerts and modular designs for easy maintenance.

The TravelMate B5 14 has a 14-inch FHD display, the TravelMate B3 Spin 12 has a convertible design with a 12-inch WUXGA screen, and the TravelMate B3 11 is designed for efficient mobile learning.

RIGHT Copilot can summarise your emails, but only one at a time

WHAT CAN IT DO?

✓ Summarising emails

In many ways, it feels like Outlook should be the app that benefits most from Copilot's presence. Wouldn't it be great to have an AI assistant that can skim through 150 unread emails, give you the skinny on the important stuff or a heads-up on what needs dealing with urgently? Yeah, don't hold your breath.

Copilot in Outlook can summarise emails, but only one at a time. You can't tell it to summarise all your unread messages or do anything with your inbox as a whole. Neither will it deal with attachments, even if they're in text-friendly formats such as PDF or even Word format, which it is of course perfectly capable of reading. Things such as school newsletters will have to be dragged into Word for a summary, which is a massive pain.

The summaries are fine if you've got a lot to read in the body of an email, but it's one of those things that comes in handy perhaps once or twice a week. It's not a game-changer in terms of productivity that an assistant capable of delving through your entire email inbox might be.

✓ Drafting messages

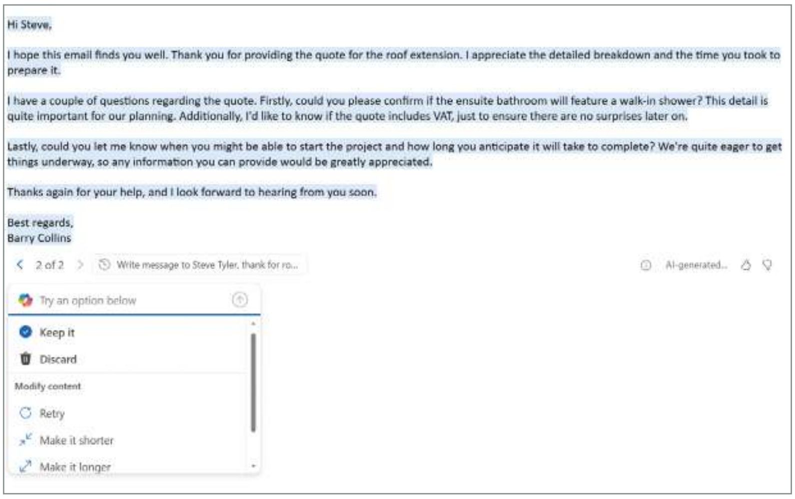
As with drafting copy in Word (*see p28*), we think the option to have AI draft your emails is going to be most warmly appreciated by those who struggle with the written word or are hunt-and-peck typists who can't rattle out even 20-30 words per minute.

Let's be clear, that's a large constituency, and Outlook's new-found ability to turn a shorthand, poorly spelt version of a message into a professional-sounding business email could certainly be of immense value. For those who are proficient typists, it's less alluring.

When you click the option to draft an email from the Copilot drop-down menu in Outlook, you're presented with suggested prompts such as "short and friendly message", "announcement" or even "create newsletter". When you click on one of these, you're left to fill in the blanks. For "announcement", for example, you have to fill in the blanks or replace the words in the square brackets: "Write an announcement for [audience] about [key topic details]. My goal is to [create excitement]."

Our tests with the various options here were mixed, though. Shorter messages are generally fine, especially if you instruct Copilot to drop the flowery language and keep it tight. However, by the time you've fed it sufficient detail to make something such as a newsletter impactful, you might as well just type the email from scratch. At best, it sorts out any glaring typos or grammatical errors.

The best results come from giving Copilot a short, telegramese-style message to convert into a fully blown email. We'd largely ignore the rest when it comes to composing messages, though.



Hi Steve,

I hope this email finds you well. Thank you for providing the quote for the roof extension. I appreciate the detailed breakdown and the time you took to prepare it.

I have a couple of questions regarding the quote. Firstly, could you please confirm if the ensuite bathroom will feature a walk-in shower? This detail is quite important for our planning. Additionally, I'd like to know if the quote includes VAT, just to ensure there are no surprises later on.

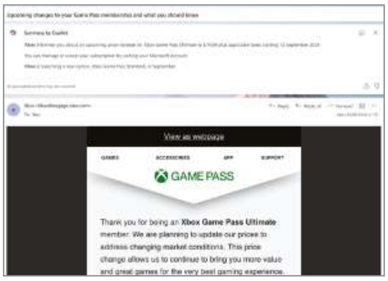
Lastly, could you let me know when you might be able to start the project and how long you anticipate it will take to complete? We're quite eager to get things underway, so any information you can provide would be greatly appreciated.

Thanks again for your help, and I look forward to hearing from you soon.

Best regards,
Barry Collins

Write message to Steve Tyler, thank for ro...

BELOW AI can draft messages for you, which could be a real timesaver



Thank you for being an **Xbox Game Pass Ultimate** member. We are planning to update our prices to address changing market conditions. This price change allows us to continue to bring you more value and great games for the very best gaming experience.

RIGHT Copilot will only work with certain versions of Outlook

WHAT CAN'T IT DO?

✗ Non-Microsoft accounts

Microsoft says that "Copilot in Outlook only supports work or school accounts, and Microsoft accounts using outlook.com, hotmail.com, live.com, and msn.com email addresses at this time. Any Microsoft account using a third-party email provider, such as Gmail, Yahoo, or iCloud, can still use Outlook, but won't have access to the Copilot features in Outlook."

On work and school accounts, we presume Microsoft means those hosted on Exchange, as it didn't work with our "work" accounts in tests (Microsoft would have no means of determining whether it was a work account or not).

That does rather cramp Copilot's style for people with multiple inboxes to monitor, if they're not in some way linked to a Microsoft service.

✗ Certain versions of Outlook

Microsoft's Outlook naming scheme has frankly descended into chaos. On Windows, there's Outlook (Classic) and Outlook (New), which is like a revamped version of the Windows Mail app. Copilot only works with the latter.

Copilot wasn't appearing in Outlook for Mac at the time of writing, but it does appear in the Android and iOS apps. It also appears in Outlook on the web (**outlook.live.com**), although again only with the Microsoft-linked accounts, as stipulated above.

It feels like you need an AI assistant just to work out if Copilot will work with your particular combination of email provider/Outlook. ●

READER OFFER

Microsoft 365 Family for £79.99

SAVE 24%

Microsoft 365
Family
1 to 6 people
12-month subscription
PC, Mac, and mobile
Premium apps with the latest updates
1 TB cloud storage per person
Advanced security

Why pay Microsoft a recurring fee of £104.99 per year when you can enjoy the same advantages for £69.99 and avoid ongoing subscriptions?

■ tinyurl.com/ms365offer **6 DEVICES** **1YR LICENCE**

To help pay for Copilot in everyone's favourite Office apps, Microsoft has quietly bumped up the annual price from £79.99 to £104.99. But there's an easy way to avoid this, and that's to buy a licence from the *PC Pro* store instead.

Here's what you get for your money.

Along with full desktop versions of Outlook, Word, Excel and PowerPoint, you also receive a copy of Microsoft's note-taking application OneNote. The suite can be installed on Windows, macOS, iOS, iPadOS and Android devices, making it simple to pick up documents on every platform you use.

What's more, the Family edition includes six licences, and while it's aimed at families there's nothing to stop you sharing with your friends, too. Our one-off fee buys you a licence for a year – from the time of activation – at which point you simply need to buy another licence from us or use the free, online-only service.

Microsoft 365 includes 1TB of OneDrive cloud storage per person, giving 6TB capacity in total. OneDrive is built into Windows 10 and Windows 11's operating system, so you can use that storage for files, photos and videos – you can then access it across all devices at any time.

Note this isn't the commercial licence, so you can't use it in a workplace. You may therefore want to buy the Business version of Office: Microsoft Office Home & Business 2024 (below).

Microsoft Office Home 2024 for £109.99 or Home & Business 2024 for £229.99

The best choice if you want a version of Office that doesn't need a subscription

■ tinyurl.com/officehome2024

1 PC OR MAC **LIFETIME LICENCE**

SAVE 8%

Microsoft
Office
Home & Business
2024

You don't need to subscribe to enjoy the latest version of Office: buy this one-PC/Mac lifetime licence and it will keep on working in exactly the same way as Office versions of old.

It includes all the usual favourites. If you buy the Home 2024 version, that means the 2024 desktop versions of Word, Excel, PowerPoint and OneNote. But if you want Outlook, or to use this version of Office in a business environment, then you'll need to pay the extra for the Home & Business 2024 edition. This also works with Microsoft Teams.

Note that both Office packages work with macOS, Windows 11 and Windows 10, but not earlier versions of Windows.

INSTANT EXPERT

AFFINITY PHOTO

Bring your pictures to life with this powerful image editor – no subscription needed. **Nik Rawlinson** introduces the best features

Whether you're shooting with a smartphone or a powerful DSLR, your photos can often benefit from a little light editing. You can tweak them with Windows' integrated Photos app, but for more advanced, professional-grade edits you'll need a more capable tool, such as Affinity Photo.

Developed in the UK by Serif (now part of Canva), Affinity Photo is part of the three-app Affinity suite, along with Designer and Publisher. It's a dedicated image-editing program, much like Adobe Photoshop, with support for a wide range of image formats, including raw files straight off the camera. It's available for Windows and macOS, and there's also an iPad edition for editing on the move.

One thing that makes Affinity Photo particularly appealing is its price. By contrast with Adobe's subscription-only licensing for Photoshop, Affinity Photo is offered as a perpetual licence costing only £68 inc VAT for Windows and macOS, or £18 inc VAT for the iPad edition. If you buy the whole Affinity suite, you get all three apps on all three platforms, plus every point-release of the version 2 builds, for £160 inc VAT. Discounts are offered for bulk business purchases and for education institutions, with Serif promising "incredibly affordable licensing options for educational purposes".

You can download Affinity Photo from the Microsoft Store, or directly from affinity.serif.com. The iPad version is available through the Apple App Store. You'll need an Affinity account to activate the software, but you can try out Affinity Photo – as well as Designer and Publisher – for free before handing over your cash.

1 Adjustable adjustment layers

Affinity Photo offers multiple levels of undo to roll back your edits, but it also makes extensive use of adjustment layers for fine, non-linear tweaking. Rather than containing pixels or other image elements, an adjustment layer defines adjustments that apply to every image layer beneath it. To better understand how this works, open an image and make sure the Layers panel is visible (if it isn't, click it in the View menu). Now click the Adjustments button at the bottom of the panel and select the kind of adjustment you want to make.

In the image opposite (*top*) we've added both "Brightness / Contrast" and "Shadows / Highlights", and you'll see a layer for each one in the Layers panel. We can now double-click on each layer to bring up a floating panel showing its available parameters, tweak the sliders and see how our image is affected.

Adjustment layers behave just like regular layers, so you can show or hide them by clicking the dot next to each entry, change their opacity using the slider at the top of the panel, and adjust their blending mode. You can also group them together with other image layers, and – perhaps most usefully – create masks to make the adjustment apply only to certain areas of the canvas, or gradually ramp up across the frame.

Working with adjustment layers means you should have little need to ever use the Undo feature. If you want to apply pixel edits such as burning or dodging, you can always make a duplicate copy of your image layer before you start, for safekeeping. This gives you the freedom and confidence to try more extensive and daring edits, and take your creativity to the next level.

2 Don't edit: develop

Whether you're using Affinity Photo to tweak your pictures, composite an image or create something original from scratch, it helps to start with an image that's close to your desired outcome. If you're using a raw photo as your start point, Photo will automatically open it in its Develop module, with sliders that allow you to adjust the exposure, black point, clarity, saturation and so on across the whole frame before you bring the image into the main editing interface.

These features aren't limited to raw images, though: any image, whether it's a JPEG, PNG, TIFF or whatever, can be edited in the Develop module by simply opening it in Affinity Photo, then clicking the Develop Persona button on the main toolbar.

When you make large-scale adjustments in the Develop module it can be easy to accidentally overdo things or lose track of what you're doing. If necessary, you can use the split-view options at the top of the window to compare the original

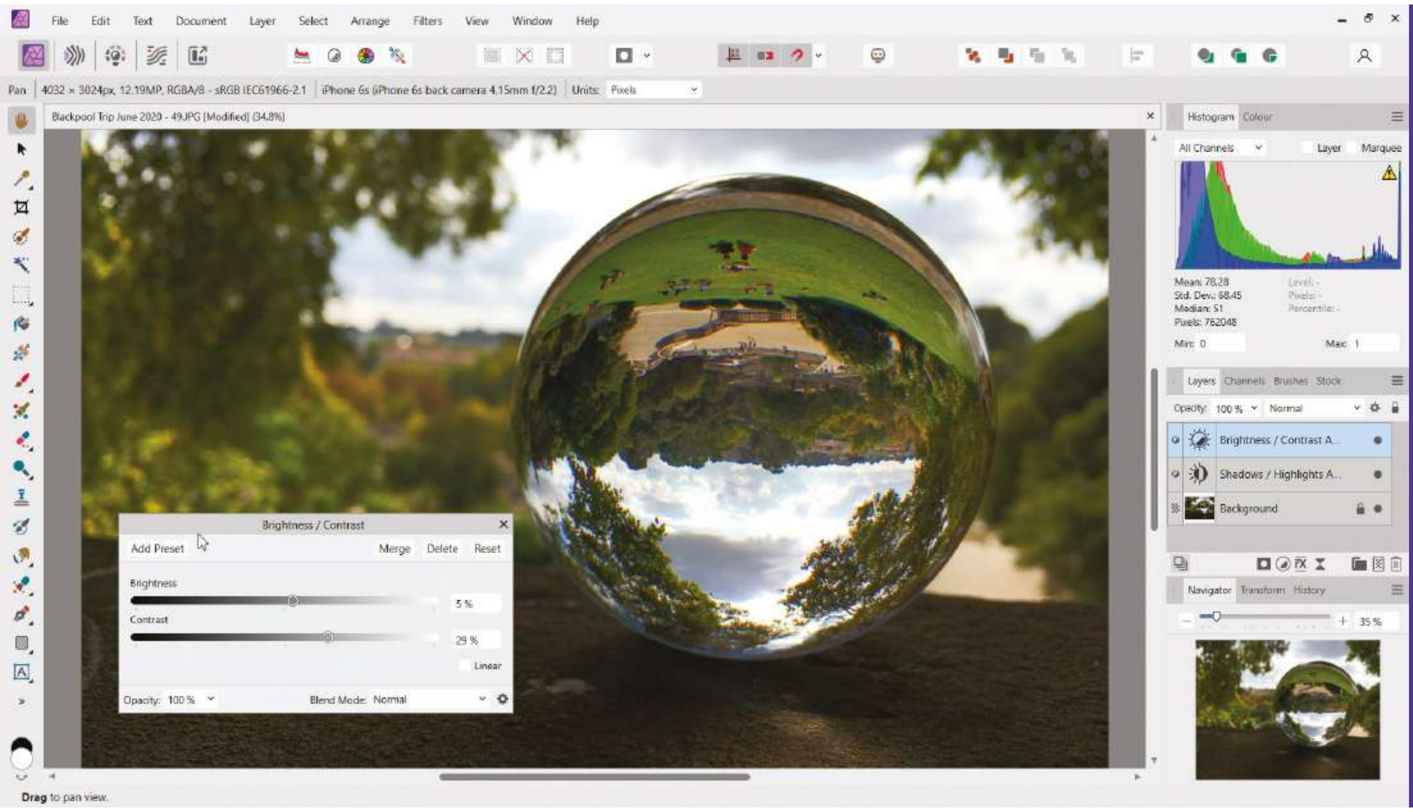

File Edit Text Document Layer Select Arrange Filters View Window Help
4032 × 3024px, 12.19MP, RGBA/8 - sRGB IEC61966-2.1 iPhone 6s (iPhone 6s back camera 4.15mm f/2.2) Units: Pixels
Blackpool Trip June 2020 - 49.JPG [Modified] (34.8%)
Histogram Colour
All Channels Layer Marquee
Mean: 78.28
Std. Dev.: 68.45
Median: 51
Pixels: 762048
Min: 0 Max: 1
Layers Channels Brushes Stock
Opacity: 100 % Normal
Brightness / Contrast A...
Shadows / Highlights A...
Background
Navigator Transform History
35 %
Brightness / Contrast
Add Preset Merge Delete Reset
Brightness 5 %
Contrast 29 %
Linear
Opacity: 100 % Blend Mode: Normal
Drag to pan view.

image with the results of your adjustments. You can also use the clipped shadows, clipped highlights and clipped tones indicators to overlay your image with colours showing where your adjustments have caused detail to get burnt out or crushed into blackness.

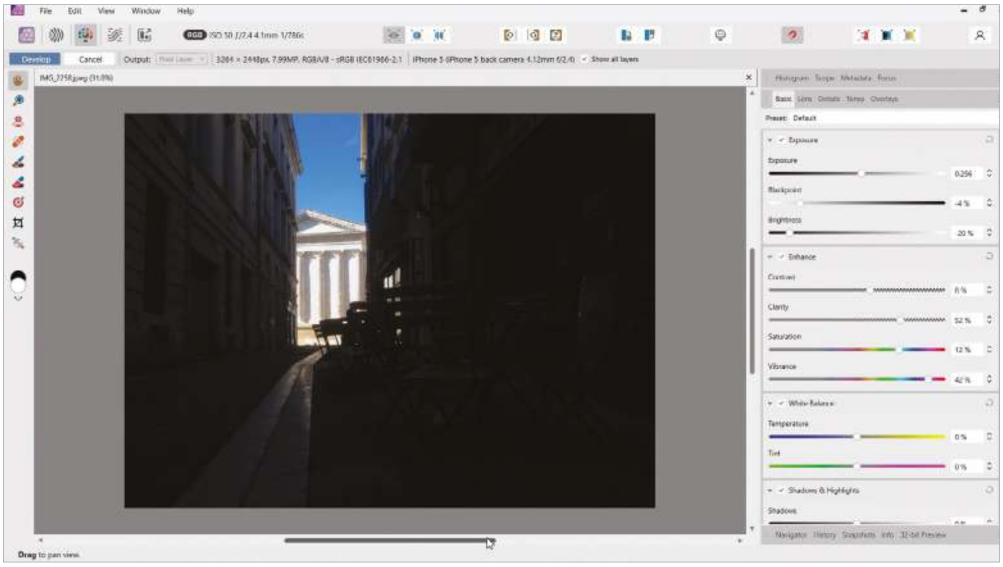
When you've finished making adjustments, click Develop and Affinity Photo will apply your changes before dropping the image into the Photo Persona, ready for further edits. You can switch backwards and forwards between the Develop and Photo Personas as often as you need while working on an image, and the same applies to the other personas for liquifying, tone mapping and exporting your work.

3 Bring out details with tone mapping

Cameras sometimes struggle to capture the full range of tones in what they see. Shoot your partner in front of a sunset, for example, and they may well end up silhouetted against a burnt-out sky. Big exposure problems can be addressed in the Develop Persona, but you can also use Affinity Photo's Tone Mapping module to rebalance the colour tones, and bring out detail and vibrancy in an image that might otherwise look murky or flat.

In our sample screenshot overleaf we're working with a photo of the famous glass ceiling of the Galeries Lafayette department store in Paris. The ceiling is backlit by daylight, while the interior has artificial lighting; the contrast between the two is pretty extreme and, as a result, some detail in the balconies and alcoves has been lost. To rectify this, we can open the Tone Mapping Persona and browse a range of presets from the drop-down menu, each of which gives the finished image a slightly different look.

It's normally best to start by exploring the options in the Default category, but here we've applied the Titus Vorenus preset from the James Ritsons Customs list, which has done a lovely job of bringing out the warm lighting and gold paint in the scene.

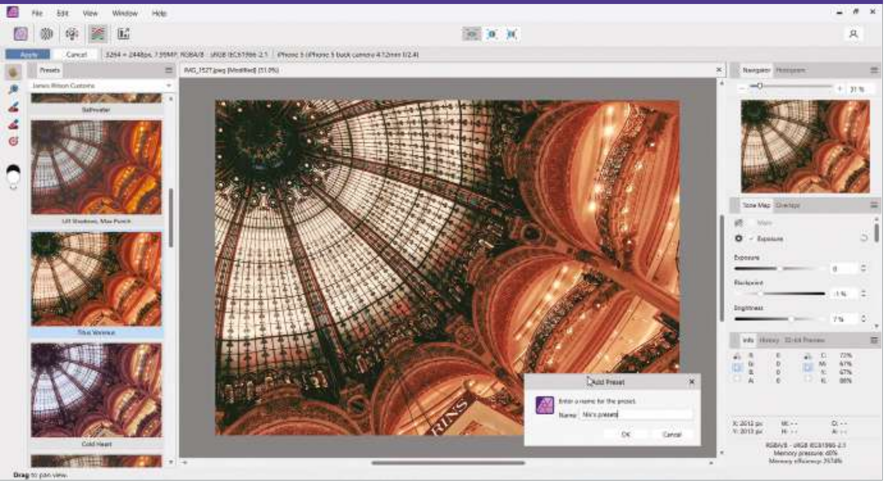

File Edit View Window Help
Develop Cancel Output
3264 × 2448px, 7.99MP, RGBA/8 - sRGB IEC61966-2.1 iPhone 5 (iPhone 5 back camera 4.12mm f/2.4)
Basic Lens Details Tones Overlays
Preset: Default
Exposure
Blackpoint
Brightness
Enhance
Contrast
Clarity
Saturation
Vibrance
White Balance
Temperature
Tint
Shadows & Highlights
Shadows
Navigator History Snapshots Info 32-bit Preview
Drag to pan view.

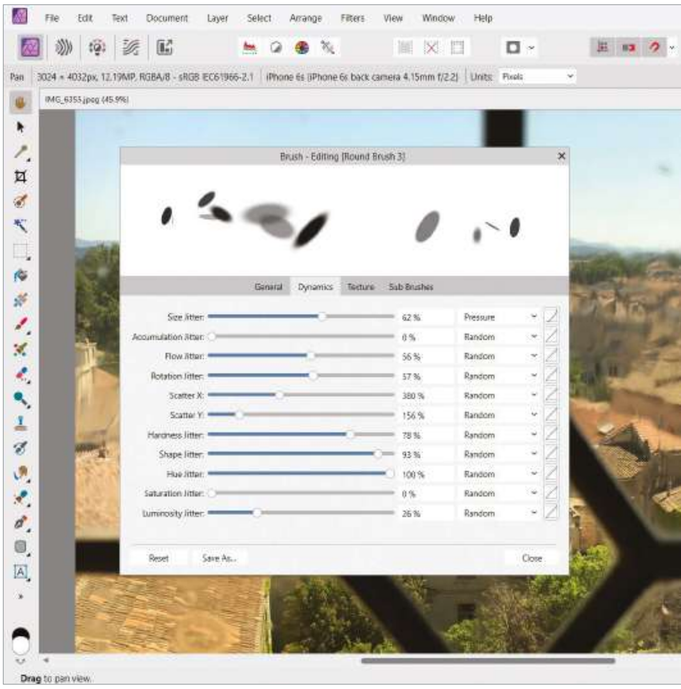
ONE THING THAT MAKES AFFINITY PHOTO APPEALING IS ITS PRICE

TOP Adjustment layers let you apply precise, non-destructive edits

ABOVE Develop Persona can make large-scale corrections to colour and tone

IF NONE OF THE SUPPLIED BRUSHES QUITE SUITS YOUR NEEDS, YOU CAN DESIGN YOUR OWN





3024 × 4032px, 12.19MP, RGBA/8 - sRGB IEC61966-2.1 | iPhone 6s (iPhone 6s back camera 4.15mm f/2.2)

Brush - Editing [Round Brush 3]

Size Jitter: 62 % Pressure
Accumulation Jitter: 0 % Random
Flow Jitter: 56 % Random
Rotation Jitter: 57 % Random
Scatter X: 380 % Random
Scatter Y: 156 % Random
Hardness Jitter: 78 % Random
Shape Jitter: 93 % Random
Hue Jitter: 100 % Random
Saturation Jitter: 0 % Random
Luminosity Jitter: 26 % Random

LEFT **Tone mapping can bring images to life with brightness and warmth**

ABOVE **Define your own brushes for interesting creative effects**

At this point we could click Apply to continue working on our image in the main Photo Persona, or use the sliders in the Tone Map panel on the right to tweak the settings to our exact requirements. For example, we might push up the exposure a little from the preset value to bring out more of the darker detail.

If you find yourself regularly applying the same adjustments, you can save time by creating your own tone mapping presets. To do so, apply your desired tonal changes to an image, then – before clicking Apply – click the three-line "hamburger" menu at the top of the presets sidebar and select Add Preset. Give your new preset a name and click OK to add it to the bottom of the current list.

If you want to move it to a different list, right-click it, then hover over "Move Preset to Category" in the fly-out menu and click the name of the list you want to use.

4 Create your own brushes

Affinity Photo comes with a good set of standard brushes, which you can use to paint directly onto an image, or refine your adjustment layers. But if none of the supplied brushes quite suits your needs, you can design your own.

To do so, open the image you want to work with, then click the Brushes panel in the sidebar. Click the hamburger menu button and select the kind of brush you want to create. We've opted for a new round brush; this will be added to the Brushes panel directly below the brush that's selected at that point.

Now right-click the new brush and click "Edit Brush…" on the context menu to pull up the editing dialog. This works in much the same way as the Develop Persona, with brush attributes tweaked by dragging sliders left and right. As you do so, you'll see the brush preview update in real-time.

As well as the basic settings on the General tab, you can switch to the Dynamics tab to introduce jitter and scatter, which create organic effects by randomising the output of the brush as you stroke it across the page. In our example we've created an interesting confetti-style brush that distributes ovals of various sizes at random orientations around the path of any stroke for which it's used.

5 Remove unwanted objects (or people) with Inpainting

While Affinity Photo doesn't use trendy AI algorithms, its smart "inpainting" tool can be used to instantly remove or clean up images in much the same way as an AI-powered image editor. For example, our photo above left, taken at Orford Ness, has people in the foreground that distract from the desolation of the area, and Affinity Photo's Inpainting tool lets us remove them with just a few clicks.

To activate it, press the shortcut J, or long-click on the Healing Brush tool to open the pop-out menu and click the Inpainting tool. Now choose a brush from the brushes palette and refine the size so you can accurately paint over the object you want to remove without including too much of the background (you can use the "[" and "]" keys to shrink and enlarge the brush). Now select the layer containing the object, paint over the unwanted elements and watch as they seamlessly vanish.

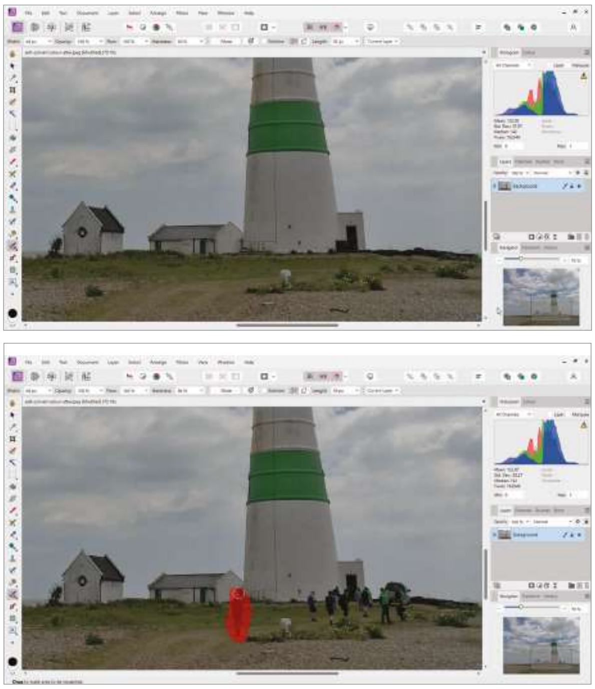
SIMPLIFY YOUR WORKFLOW WITH STUDIOLINK

While Affinity Photo works perfectly well on its own, it also integrates slickly with the companion Designer and Publisher applications. An impressive feature called StudioLink lets you use tools from Photo and Designer directly within Publisher, to tweak and edit images on the page without having to switch between applications.

If you have Affinity Publisher, you can try this out for yourself: first, create a document in Publisher and place an image using the shortcut Ctrl+Shift+M. Click the image so it's selected, then click the Photo Persona button on the top toolbar. This brings up an interface that's similar to Affinity Photo's tools and panels within Publisher itself, allowing you to make significant changes to your image on the page. For example, in the screenshot opposite, we've applied a black and white adjustment layer to the image, which now appears within the Publisher layers panel. We can go on to apply as many others as we require before clicking the Publisher Persona button to switch back to the Publisher tools.

RIGHT **The three apps in the Affinity Studio suite work tightly together**

Histogram Colour
All Channels
Layer
Marquee
Mean: 155.82
Std. Dev.: 83.59
Median: 156
Pixels: 762048
Min: 0
Max: 1
Layers Channels Brushes Stock
Basic
Round Brush
Round Brush 2
Round Brush
Navigator Transform History
46 %



Inpainting works by sampling the surrounding pixels and using them to generate new colours and textures in the areas you've just erased. If the tool doesn't quite get it right first time, try again in the same area; we've found that we got the best results when focusing on small areas, and removing elements one or two at a time, rather than trying to do everything at once.

Going mobile

While Affinity Photo is a powerful desktop tool, if you have an iPad it's also well worth trying the tablet version. It's great being able to use an Apple Pencil to make edits – particularly when brushing out blemishes using the clone stamp, or painting in layer masks to control the areas to which adjustments apply. Naturally you'll get the best experience from a big-screen model such as the 13in iPad Air or iPad Pro, but the program will run on something as small as an iPad Mini.

Serif also offers iPad versions of Designer and Publisher, and again these are well worth a look: once you're familiar with Affinity Photo, you'll find a lot of your skills and knowledge will transfer to the other apps, and the benefit of StudioLink, outlined below, can't be overstated when putting publications together.

ABOVE Inpainting lets you erase unwanted photo elements by painting over them

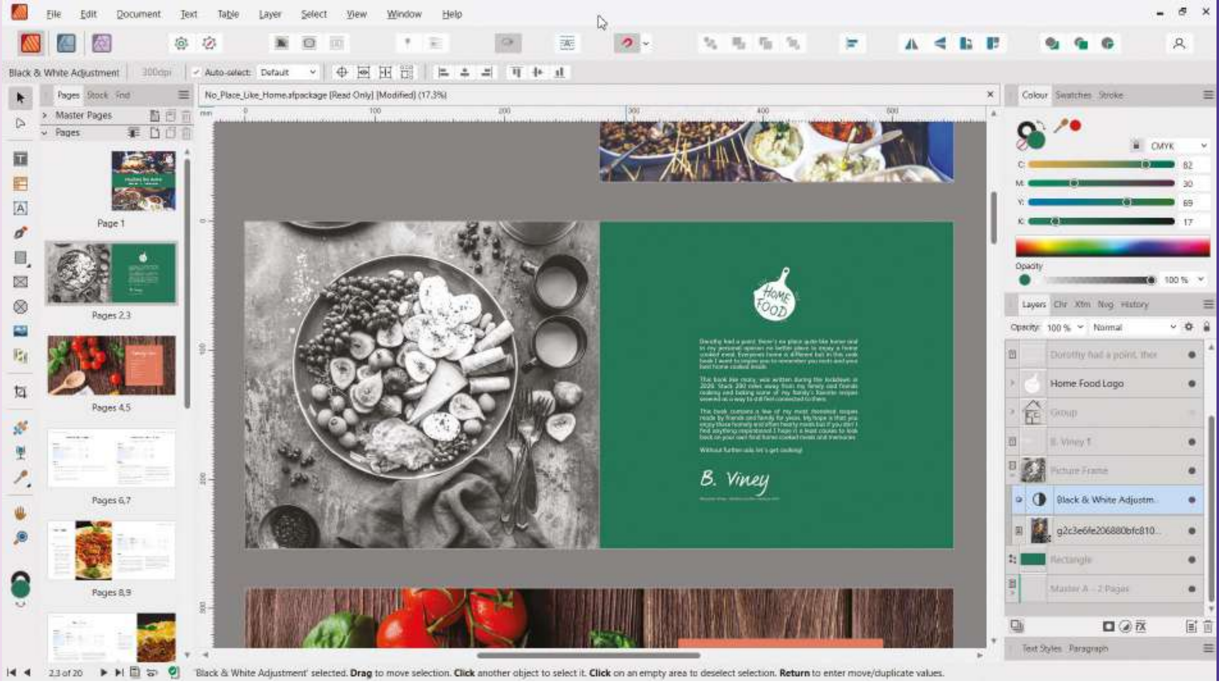
AFFINITY PHOTO ALTERNATIVES

If you're looking for something even cheaper than Affinity Photo, Photopea is a great free online image-editing suite – find it at photopea.com, and see issue 364 for our guide. Alternatively, there's always the open-source GIMP (gimp.org); as well as supporting Windows and macOS, GIMP runs on Linux and includes full support for layers and adjustments. However, the GIMP's user interface takes some getting used to, and it lacks a dedicated raw image-editing module like the Develop Persona found in Affinity Photo.

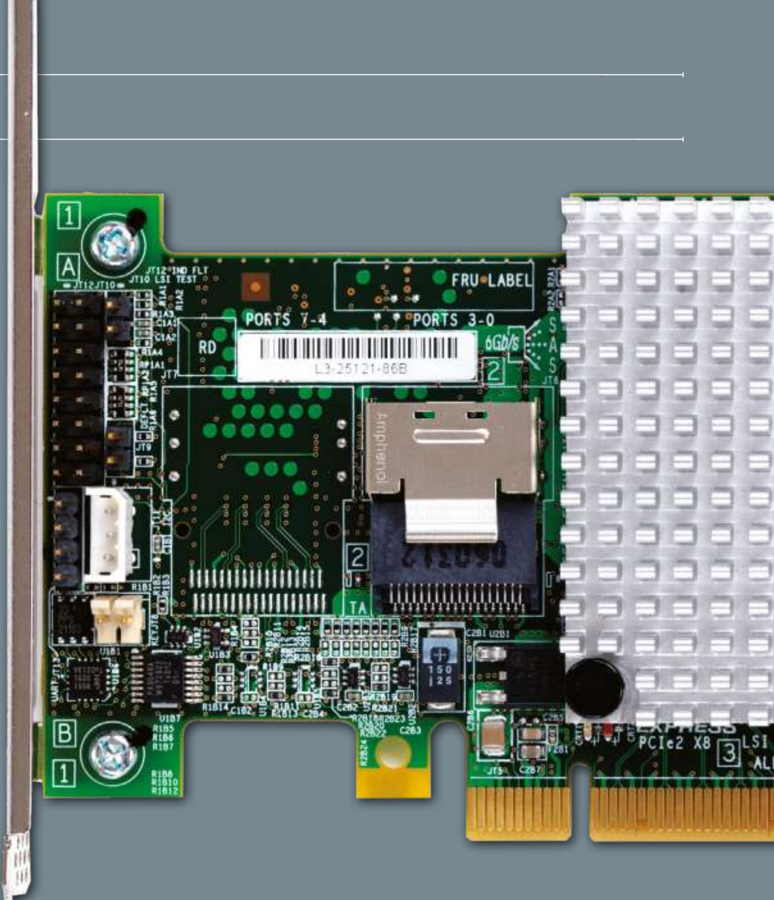
Corel's PaintShop Pro (paintshoppro.com) is another paid-for tool that works similarly to Affinity Photo. It's also sold as a perpetual licence, with features including raw image editing and focus stacking to increase depth of field. It has AI tools for removing artefacts, upscaling, replacing backgrounds and more, and costs £70 inc VAT, which is almost the same as Affinity Photo.

For truly professional-grade image editing, the original Adobe Photoshop (adobe.com) remains the industry standard. It's a lot more expensive than Affinity Photo – the cheapest subscription bundle costs around £20 a month – but it has numerous features that Affinity lacks, such as automation, 3D warping and generative AI. Its long history and huge user base also mean that there's a vast wealth of tutorials and plugins available online.

If your work is focused primarily on editing raw photos, you might also consider Adobe Photoshop Lightroom or Capture One Pro (captureone.com). Each boasts professional-grade photo-enhancement tools and feature-rich interfaces, with an emphasis on full-frame adjustments rather than pixel-based image editing, although it's still perfectly possible to make local tweaks and corrections as needed. ●


File Edit Document Text Table Layer Select View Window Help
Black & White Adjustment
300dpi
Auto-select: Default
Pages Stock Find
Master Pages
Pages
Page 1
Pages 2,3
Pages 4,5
Pages 6,7
Pages 8,9
No_Place_Like_Home.afpackage [Read Only] (Modified) (17.3%)
Colour Swatches Stroke
CMYK
C: 82
M: 30
Y: 69
K: 17
Opacity 100 %
Layers Chr Xfm Nvg History
Opacity: 100 % Normal
Dorothy had a point, ther
Home Food Logo
Group
B. Viney 1
Picture Frame
Black & White Adjustm.
g2c3e6fe206880bfc810...
Rectangle
Master A - 2 Pages
Text Styles Paragraph
2,3 of 20
HOME FOOD
B. Viney

'Black & White Adjustment' selected. **Drag** to move selection. **Click** another object to select it. **Click** on an empty area to deselect selection. **Return** to enter move/duplicate values.



Expansion cards may seem an old concept, but **Darien Graham-Smith** finds out how PCI Express remains on the cutting edge of interconnect technology

Why PCI Express rules the world

In a world filled with laptops, smartphones and tablets, the very idea of PCI Express (now commonly shortened to PCIe) might seem outdated. After all, the standard was originally laid down way back in 2003, four years before iPhones – a world where big-box desktop PCs ran Windows XP, and jumbo-sized expansion slots could be used to install anything from a sound card to a modem.

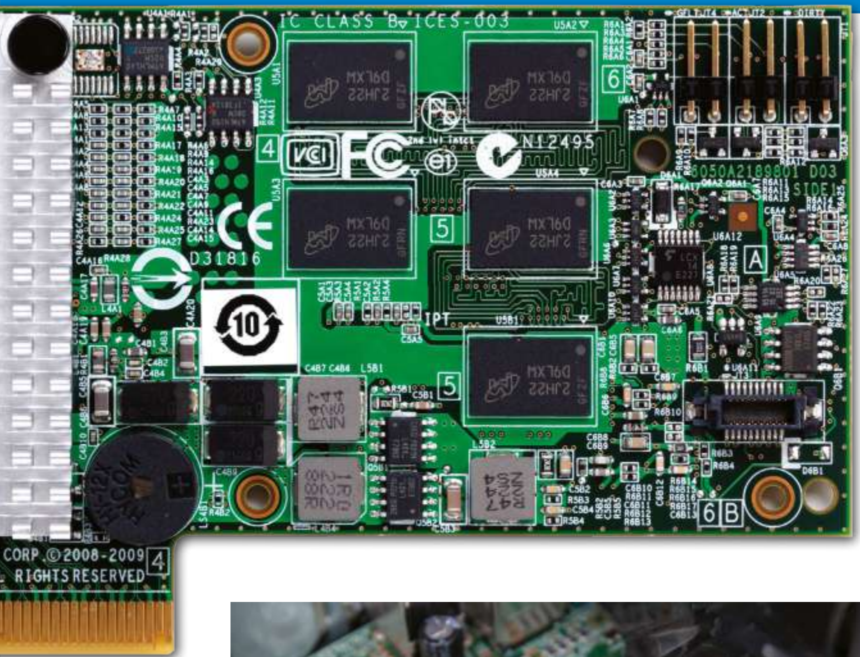
Today, only a minority of us are still using those classic full-sized tower PCs. And even if your motherboard does have PCIe expansion slots, you may never have to use them: most mainstream CPUs include their own built-in graphics processors, so you can get by quite happily without even needing a graphics card, and everything else you need for daily computing is nowadays built into the motherboard.

Yet PCIe as a technology shows no signs of dying. More than 20 years on, it keeps on evolving through subsequent generations, becoming ever faster and more efficient. So why is this technology still so popular, and what's the secret to its extraordinary longevity?

What is PCI Express?

Simply put, PCI Express is a data bus that connects some sort of outboard device or resource to the motherboard, allowing it to communicate bidirectionally with the CPU and system memory. The technology is developed and maintained by a cross-industry group called PCI-SIG, which includes representatives from AMD, Arm, Dell EMC, IBM, Intel, Nvidia and Qualcomm. PCI-SIG standards specify how signals are exchanged electronically over a PCIe bus, and also define how the connection is physically implemented, in the form of card slots or other connectors – ensuring that any compliant PCIe card will work in any compliant slot, regardless of the manufacturer or card type.

There's nothing particularly revolutionary about this. The idea



Longer slots have more pins, so they can carry more "lanes" of data and provide a faster connection

TOP **PCIe is ideal for graphics cards, but…**

ABOVE **…different sized slots make it suitable for many other roles as well**

of expansion cards dates back at least to the 1980s, when connectors such as ISA and MCA were widely used to add capabilities to basic motherboards. The PCI-SIG itself has been going since 1992, when it created the first PCI card standard.

The difference is that none of those earlier standards lasted much more than ten years before being superseded by something faster and smarter. PCI Express, by contrast, has survived for twice as long – and looks set to carry on far into the future – because it was designed from the outset as an open-ended standard, capable of evolving with the times while retaining forward and backward compatibility.

In fact, we've already lived through six major generations of PCIe. Each one has brought a significant boost to performance, to the extent that the latest PCIe interfaces are more than 30 times as fast as the original specification – yet a card made in 2003 will still work in a computer from 2025, and vice versa.

Who needs PCIe?

That's a fair question. As we've observed, modern computers tend to come with everything you need built in. The early days of personal computing, when key components such as disk controllers and printer interfaces had to be installed on foot-long daughterboards, are all but forgotten.

Modular expansion still has its benefits, however. One obvious use for an expansion slot is to install a dedicated graphics card – and replace and upgrade it when a better, faster one comes out. PCIe is also perfect for attaching high-speed storage, especially if you're using a computer whose primary storage is soldered to the motherboard and can't be replaced with a larger one.

In other words, the standard expansion card model still has a place, even in a world that's moved towards compact, integrated system designs. Indeed, one of the clever things about PCIe is that you don't necessarily need a full-sized expansion slot to take advantage of it.

The wacky world of PCIe slots

Before PCIe, expansion slots were rigidly defined: a PCI card, for example, had to be manufactured in one of a small number of standard sizes, with 120 contacts at the bottom, arranged to fit into an 80mm slot on the motherboard.

The PCI Express standard is much more versatile. It allows for card connectors and slots of four different lengths – 25mm, 39mm, 56mm and 142mm. Longer slots have more pins, so they can carry more "lanes" of data at once and provide a faster connection, while shorter slots allow for more compact and economical hardware designs. The different slot sizes (and corresponding data rates) are formally known as x1, x4, x8 and x16.

The best part is that you don't even need to match up the card and slot lengths. A card with a short x1 connector can plug into an x8 or x16 slot and it will work just fine, though obviously it won't be taking full advantage of the bandwidth the slot can support. Even more impressively, a card with a long x16 connector will work perfectly well in a shorter x1 or x4 slot, although its data throughput may be limited. Some motherboards prevent this by using slot housings with closed ends, so longer cards won't physically fit – but if you're feeling brave you can take a saw or a pair of snips and carefully open up the "wall" at the end of the slot, allowing you to insert anything you like.

While we're on the subject, PCIe slots often also have a retention clip at the end that holds the card firmly in place once it's been inserted. This isn't a mandatory part of the standard, but it's another welcome improvement; older PCI cards didn't directly attach to the motherboard, and were instead held in place by securing the end bracket to the

An external M.2 enclosure works just like an SSD plugged directly into a PCIe slot on the motherboard

ABOVE The M.2 format makes it possible to fit PCIe cards in laptops and mini-PCs

computer case. Old hands may remember the frustration this caused when a rickety chassis made it all too easy for cards to become unseated.

No slots please, we're mobile

If you thought PCIe's approach to slots was admirably versatile, you ain't seen nothing yet: the standard doesn't actually require slots at all, and can be implemented over numerous other types of physical interface. One of the most familiar is the M.2 interface, commonly used for SSDs and wireless cards. This compact 22mm connector is in fact a PCIe x4 slot in disguise; it can support optional controllers for cards with SATA or USB interfaces, but if you plug in an NVMe SSD it will get a direct PCIe connection to the host, exactly as if you were using a full-sized expansion slot.

It's also possible to connect external peripherals via PCIe using a little technology you may have heard of called Thunderbolt. Similar to M.2, a Thunderbolt socket can support USB devices, and can also carry DisplayPort data to an external display, but at bottom it's another PCIe x4 connection. This makes it ideal if you want to attach the fastest possible external storage to a laptop or an all-in-one system that won't take an internal upgrade: an external M.2 enclosure with a Thunderbolt link back to the host computer works just like an SSD plugged directly into a PCIe slot on the motherboard.

While those are the most common variant implementations of PCIe, specialist interfaces also exist that run PCIe over optical cables, for fast, low-latency connections over medium distances. Another technology called ExpEther operates PCIe over a standard Ethernet connection, for a comparatively slow but highly versatile and robust interface.

OWC
ENVOY ULTRA

BELOW Thunderbolt implements PCIe over a convenient cable link

PCIe versions

The clever engineering we've discussed above applies to all PCIe interfaces, from the very first sample cards produced back in the early 2000s to the most recent high-end motherboards. Indeed, from a user's point of view nothing has changed from the first revision of PCIe – except for the speeds available, which have rocketed up at a remarkable pace through the generations. Aside from minor point updates, here's how things have progressed.

2003

PCIe 1.0, up to 4GB/sec

The original release of PCIe was designed to convey 250MB/sec of bidirectional data over a single lane, so an x4 connection could handle 1GB/sec and an x16 card in a compatible slot could go as high as 4GB/sec.

2007

PCIe 2.0, up to 8GB/sec

The first major update to the PCIe standard doubled the data-encoding frequency, increasing the top transfer rate to a maximum of 8GB/sec over an x16 connection.

2010

PCIe 3.0, up to 15.8GB/sec

For reasons of reliability and electrical stability, the first two PCIe revisions transferred eight-bit chunks of data in the form of ten-bit symbols, meaning 20% of all data transferred across the interface was "padding". PCIe 3 introduced a much more efficient encoding method, using 128-bit data words encoded as 130-bit symbols. At the same time, the data rate was increased by 60%; the combined effect was to very nearly double the speed of an x16 connection again, to a maximum of 15.8GB/sec.

2017

PCIe 4.0, up to 31.5GB/sec

The next version of PCIe took a while to appear – perhaps because it ambitiously once again doubled the speed of the interface, reaching a maximum of 31.5GB/sec.

2019

PCIe 5.0, up to 63GB/sec

In light of the technical challenges faced getting to PCIe 4, the PCI-SIG initially explored the idea of a more cautious 1.6x speedup for PCIe 5, but before long it had managed to achieve yet another doubling of bandwidth, bringing the top data rate up to a massive 63GB/sec.

2022

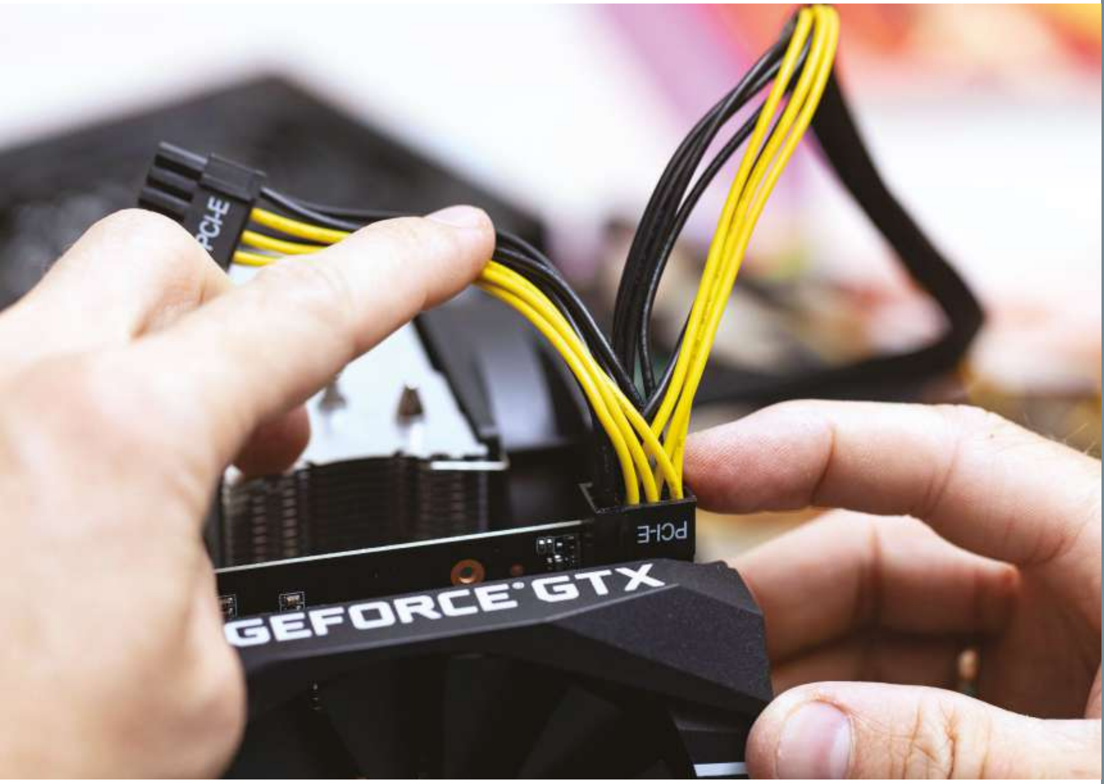
PCIe 6.0, up to 121GB/sec

By using pulse-amplitude modulation – along with advanced error-correction techniques – the newest PCIe standard packs more information into the electrical signal than ever before, taking the maximum throughput to an enormous 121GB/sec. That's so fast that, even though the standard was finalised several years ago, it's still considered overkill for most purposes (see "What version of PCIe do I need?", opposite).

2025

PCIe 7.0, up to 242GB/sec

You can't stop progress, and even though PCIe 6 hasn't yet hit the



mainstream, the PCIe 7 standard is already on track to be finalised this year. The plan is to – guess what? – double the effective clock rate once again, for an insane maximum transfer rate of 242GB/sec.

However, achieving that without compromising reliability will require tighter, more precise electronic engineering than any previous generation, so it's doubtful that PCIe 7 technologies will reach the mass market any time soon – especially since there are very few applications that need that sort of speed.

Powering up

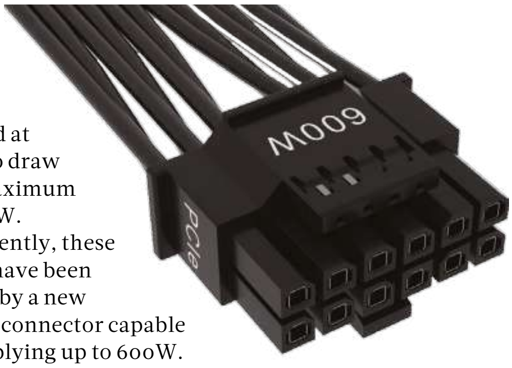
While PCIe is primarily about data, the standard also includes power specifications. Alongside the data connections, every PCIe slot has two +12V pins, allowing cards to operate without an external power source. PCIe x1 cards can draw up to 25W of power, while larger cards can go up to 75W; more compact connectors also provide power, with M.2 and Thunderbolt connectors usually delivering up to 10W.

While this is enough to drive a network card or SSD, it won't do for a high-end graphics card. For expansion cards that need more juice than the slot can provide, the PCIe standard defines a selection of high-power sockets that can connect directly to the computer's main power supply. Both six- and eight-pin connectors are in common use, supplying 75W and 150W respectively; two connectors can be used at once to draw to a maximum of 300W.

Recently, these plugs have been joined by a new 16-pin connector capable of supplying up to 600W. The catchily named 12VHPWR connector made its debut on the Nvidia RTX 4090 and looks likely to replace the older six- and eight-pin standards on newer cards and power supplies. For those still using an older power supply, a simple adapter cable can be used to combine multiple eight-pin plugs into a single 16-pin connector.

Although all PCIe cards are powered to some extent, not many people realise that they can be "hot-swapped". You can pull a card out of its slot at any time, and even drop in a new one, while the computer is still running, without causing any damage. This extends to M.2 devices, and of course to Thunderbolt as well.

However, swapping cards with the power on isn't recommended as regular practice – not because it's dangerous to the hardware, but because the operating system or apps might crash when the GPU or hard disk configuration abruptly changes in the middle of a session.



TOP Six- and eight-pin power connectors let PCIe cards draw up to 300W of power...

ABOVE ...and the new 12VHPWR connector doubles the maximum wattage to 600W

What version of PCIe do I need?

Because PCIe is so gloriously cross-compatible, you very rarely need to worry about which precise version of the interface your hardware supports. However, if you're shopping for a new PC, you might be concerned about future-proofing. While mid-price systems often still use PCIe 4, PCIe 5 has become standard on high-end motherboards – and it may not be long before PCIe 6 boards start to appear.

How much this matters depends on exactly you want to connect. Surprisingly, a high-end graphics card won't necessarily benefit from a top-speed PCIe interface. Once a game's assets and code have been loaded onto the card, the GPU mostly works locally, using its own dedicated graphics memory and display outputs; adding a faster connection to the CPU and system RAM makes little difference to overall performance. For this reason, almost every graphics card on the market is still using a PCIe 4 interface, and while Nvidia's very latest RTX 5080 and 5090 cards have introduced support for PCIe 5, it remains to be seen whether they'll see any performance benefit from the faster connection.

When it comes to storage, however, connection speed can make a big difference. Although a full-width PCIe 4 connection has a throughput of around 32GB/sec, you'll recall that the M.2 interface only uses four data lanes, so the maximum possible transfer speed for an SSD attached to a PCIe 4 interface is around 8GB/sec.

That's still a mighty fast drive – it's around 16 times faster than the fastest SATA SSD, and more than 60 times as fast as a traditional hard disk. Even so, the SSD chips themselves are capable of even higher speeds, so if you're looking for low-latency access to very large quantities of data – for example, if you're working with high-resolution video – you really can get a benefit from investing in PCIe 5. There are plenty of compatible motherboards and SSDs out there; we've found many of them work at around 12GB/sec, rather than the theoretical maximum of 16GB/sec, but that's a still huge increase over PCIe 4.

Is it worth thinking about PCIe 6? Probably not yet. Last August, chip manufacturer Micron released the world's first PCIe 6 SSD, promising transfer speeds of up to 26GB/sec, but that's a costly specialist part aimed at data centres. We'd suggest you don't hold out for a PCIe 6 consumer drive unless you're willing to wait a long time – possibly years. ●

AI EVERYWHERE

WHAT'S NEW WITH 3CX V20 UPDATE 5

Forget fluffy promises about what AI can do in the future: use it to help build better relationships with your customers – and drive sales – right now

There's only one way to stay ahead of the competition, and that's to keep improving. This certainly appears to be 3CX's approach, as it has won *PC Pro*'s annual roundup of business phone systems for almost a decade. With this update, it's embracing AI more than ever before – but not as a tickbox exercise, instead focusing on ways it can help drive its customers' business.

Those customers now include over 350,000 companies, with 3CX trusted by everyone from BMW to Coca-Cola and Porsche. Now those businesses can benefit from automatic AI transcription of voicemails, enhanced AI analytics and a streamlined admin interface. Here are just a few of the highlights from 3CX V20 Update 5.

Automatic AI transcription

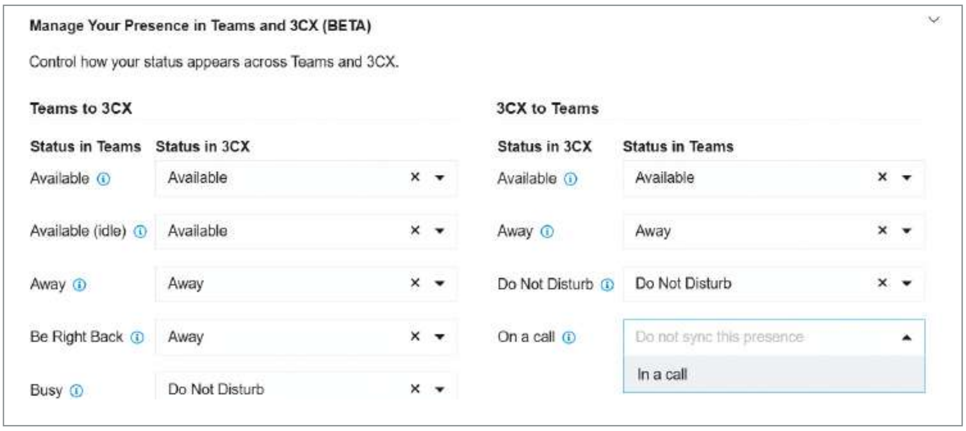
There are few things more annoying than listening to rambling voicemails that hide away key details right at the end – forcing you to listen to the whole thing over again as you realise you didn't catch it in time. Automatic transcriptions are a brilliant way to avoid this tedium, while also providing a searchable archive for keywords.

With 3CX V20 Update 5, all PRO subscribers benefit from free voicemail transcription using the OpenAI and Google engines. Previously, only ENT users could take advantage of OpenAI voicemail transcription. What's more, any PRO and ENT users with more than eight simultaneous call (SC) licences can use the custom 3CX engine for transcription, which has been specially created for call centres.

And you don't need to do a thing, other than enable it. What's more, if you're using the 3CX engine for voicemail transcription then it will be served faster, so as soon as you receive a notification of a new voicemail you can check its transcription. Perfect if you're caught up in a meeting and can't listen to voicemails there and then.

If you want to go beyond voicemails, 3CX offers call transcription too. Again, this is a great way to capture key information – and analyse it for customer sentiment. The 3CX engine is now available to all ENT users with 8SC licences and above.

BELOW **V20 Update 5 gives businesses even easier access to customer data**



Manage Your Presence in Teams and 3CX (BETA)

Control how your status appears across Teams and 3CX.

Teams to 3CX

Status in Teams	Status in 3CX
Available	Available
Available (idle)	Available
Away	Away
Be Right Back	Away
Busy	Do Not Disturb

3CX to Teams

Status in 3CX	Status in Teams
Available	Available
Away	Away
Do Not Disturb	Do Not Disturb
On a call	Do not sync this presence In a call

RIGHT You can take fine control over presence status in Google Workspace and Microsoft 365

Enhanced AI analytics

We all want a better understanding of our customers, but the sheer volume of information can be overwhelming. One of 3CX's key aims with V20 Update 5 is to give businesses easy access to this data and to present it in an attractive way.

This includes an instant mood analysis, so that you can track customer sentiment across agents and queues to identify trends as they develop. More detailed, AI-powered reports can track sentiment and performance trends across logs, extensions, ring groups and queues. And, as described above, 3CX offers a range of transcription services across voicemails and calls that you can analyse at your leisure.

You can drill down deeper, too. For example, you can track the effectiveness of particular agents over time, including an operator empathy rating. 3CX can also suggest follow-up topics, as well as keeping track of products and companies mentioned during calls – and you can ask natural language questions in a familiar chatbot interface.

As time goes by, and AI tools improve yet further, 3CX is committed to making it as easy as possible to understand your customers, measure and boost your agents' performance and help you grow your business as a result.

Google Workspace & Microsoft 365 integration

Whether you use Google Workspace or Microsoft 365, 3CX V20 Update 5 offers deeper integration than ever before. The biggest change is to Google Workspace, with support for quick and easy synchronisation of users, personal contacts, calendars and user profile photos.

It's also become much easier for Google Workspace users to sign on, thanks to support for single sign-on (SSO). This not only reduces issues arising from forgotten passwords but also cuts down on helpdesk requests. Add support for extension number mapping and Workspace has never been easier to set up.

Microsoft 365 users already benefited from these features, and you may remember that Update 4 made it even simpler to synchronise presence information between Teams and 3CX. Now, you can configure what status to sync and how that shows in the other system. For example, you might want a 3CX status of "Away" to show as "Do Not Disturb" in Teams.

And it's worth emphasising how closely 3CX and Microsoft 365 integrate – it's one of the features that lifts 3CX apart from its rivals. Not just the seamless interaction between Teams and 3CX, including the ability to connect the platforms to reduce Teams' licences and cut costs, but also the fact that you can automatically store call recordings and backups in SharePoint. Your users can even start calls directly from the Microsoft 365 interface.

ABOVE It's easy to track the effectiveness of individual agents

Streamline admin

3CX aims to make life easier for admins with every release, and V20 Update 5 is no different. For example, admins can now generate temporary links for remote access to the Web Admin Console. That could be particularly useful if 3CX partners, or 3CX itself, needs to provide technical support or troubleshoot a problem. Provide a temporary link, let them solve the issue, terminate access.

3CX has also provided two new call flow scripts to simplify how calls are managed. First up, Inbound Caller ID Routing. This script matches incoming caller IDs with predefined rules and routes them to the destination you specify. Updates are quick and effortless, with no need for regular manual imports or adjustments.

Then there's the new script to ensure anyone calling a direct number is routed to the right person or department. This script imports each DID (standing for direct inline dialling) and includes the inbound route so they can be automatically assigned to the specified extension. Now, admins can update routing rules easily without needing to import changes.

It's also easier to manage multi-tenant setups with a bunch of new features. Highlights include trunk creation for department owners, transcription control per tenant, holiday prompts and configurable paging and multicasting. Together, that means V20 Update 5 provides more flexibility and control for admins managing multi-tenant setups than ever before.

Conclusion

As ever, all these changes are simply one update to what is already *PC Pro*'s A-Listed phone system. One that Dave Mitchell described as "the perfect solution for businesses that want total control over their VoIP services".

You have full control on how to host it, too, as explained in the boxout. And you don't need to spend a penny, because 3CX is still sticking to its mantra of free forever (for up to ten users). All you'll need is an account at a supported SIP trunk provider to supply your numbers – they will give you the phone lines, which you can connect to your 3CX for inbound and outbound calling.

Simply sign up for your free 3CX SMB Free account using the link below and follow the instructions.

3 WAYS TO HOST 3CX

One much-loved feature of 3CX is that it allows you to host the Phone System however you like. Here, we run through the three main options.

1 Hosted by 3CX

This is a nice and simple option as you leave system management to 3CX, including all upgrades, updates and daily backups. Prices start at £320 exc VAT for an 8SC PRO licence, which is enough for up to 25 users.

2 Private cloud

More technical users may prefer to run 3CX in their own private cloud, with a choice of Google, Amazon, Amazon Lightsail, Azure and DigitalOcean as cloud providers. 3CX is free (up to ten users), but you will of course have to pay for your hosting costs and the SIP trunk provider.

3 On-premise

You can also install 3CX on Windows or Linux (you'll need to virtualise using VMware, Hyper-V or KVM) and run it in your office. You'll need a static IP address and a firewall that allows you to configure the ports properly, but you may be surprised that it can even run on a Raspberry Pi...

Try 3CX FREE www.3cx.com/signup

Looking for a particular past review? Visit our index at pcpro.link/index

RTX 5080
GEFORCE RTX

Nvidia GeForce RTX 50-series

AI and Multi Frame Generation are the stars of this release rather than the silicon, but these alone give reasons to buy

PC PRO RECOMMENDED RTX 5080

RTX 5080
SCORE ★★★★☆
PRICE Founders Edition, £816 (£979 inc VAT) **from nvidia.com**

RTX 5090
SCORE ★★★★☆
PRICE Founders Edition, £1,616 (£1,939 inc VAT) **from nvidia.com**

With a trio of major architectural changes, you can see why Nvidia kept us waiting almost two years for an update to its RTX 40-series. First up is its move to a 4nm process from 5nm, while it has also made the jump from PCIe 4 to PCIe 5 (*see "Why PCI Express rules the world", p40*).

But the biggest hardware change the new Blackwell architecture brings is GDDR7 video memory – and it's far faster than GDDR6 and GDDR6X. For example, the RTX 5090 has a roughly 33% increase in Gbits/sec over the RTX 4090. Add the much wider 512-bit memory interface and you have a memory bandwidth of 1,790Gbits/sec for the 5090 compared to 1,010Gbits/sec for the 4090. The new RTX 5070 Ti and RTX 5070 cards will reap similar benefits.

This, together with an enormous 32GB of VRAM, means the 5090 is the first 8K-capable graphics card on the market. 8K textures have an enormous footprint in memory, so moving them through the rendering pipelines to generate playable frame rates wasn't feasible until now – unless you used aggressive upscaling.

The Nvidia RTX 5080's memory also has a much faster effective speed of 30Gbits/sec compared to the 23Gbits/sec of the RTX 4080 Super and 22.4Gbits/sec of the RTX 4080. Again, that matters when it comes to rendering complex scenes at high resolutions: you get that much more headroom before memory becomes a brake on performance.

Aside from the memory, the RTX 5080 isn't a huge hardware upgrade over the RTX 4080 (*see the comparison table on p48*). Nvidia is instead putting its faith in AI when it comes to real-world gaming improvements.

Neural shaders

With the RTX 50-series, Nvidia has finally given programmable shaders direct access to the Tensor Cores. That allows for what Nvidia is calling Neural Shaders.

Previously, the Tensor Cores could only be accessed using CUDA, but in collaboration with Microsoft, Nvidia has created the Cooperative Vectors API, which allows any shader – whether pixel or ray tracing – to access the matrix calculating cores in both DX12 and Vulkan. This allows developers to bring a bunch of AI-powered features to their games.

It also means AI is deeply embedded into the rendering pipeline, which is why we have a new slice of silicon in the Blackwell chips to help with this extra workload. The AI Management Processor, or AMP, helps to schedule both generative AI and AI-augmented game graphics, ensuring they can be processed concurrently in good order.

The Cooperative Vectors API will allow for features such as neural texture compression, which is touted to deliver 7x savings when it comes to VRAM usage. It also paves the way for AI models to bring us ever closer to photo realism.

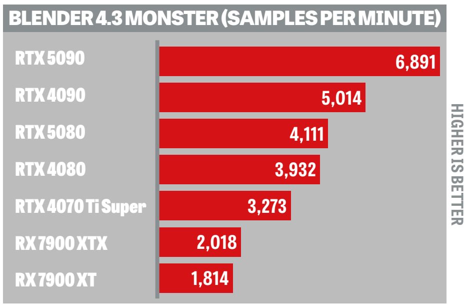
ABOVE The RTX 5080 and 5090 offer huge performance boosts over the RTX 40-series

> **"The biggest hardware change the Blackwell architecture brings is GDDR7 video memory – and it's far faster than GDDR6 and GDDR6X"**

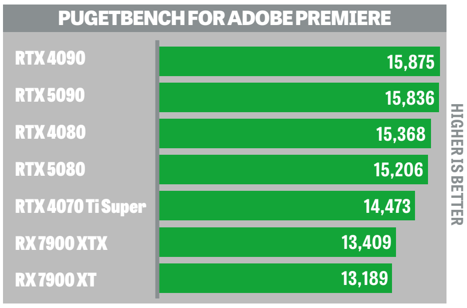
BELOW The RTX 5090 Founders Edition card is now double height rather than triple

PROFESSIONAL & CREATIVE BENCHMARKS

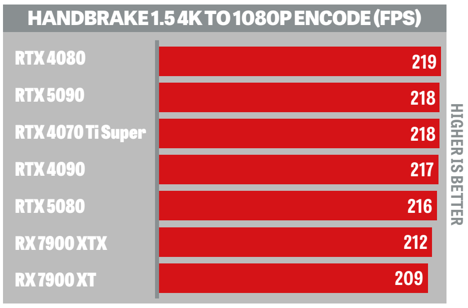
BLENDER 4.3 MONSTER (SAMPLES PER MINUTE)



PUGETBENCH FOR ADOBE PREMIERE

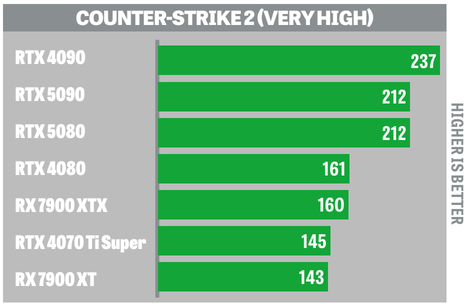


HANDBRAKE 1.5 4K TO 1080P ENCODE (FPS)

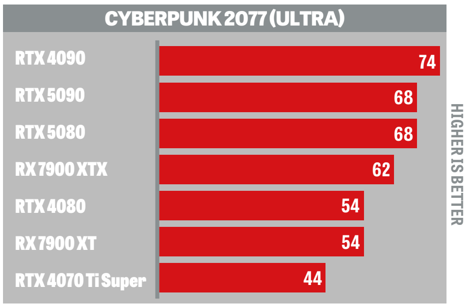


4K GAMING (NO RAY TRACING, AVERAGE FPS)

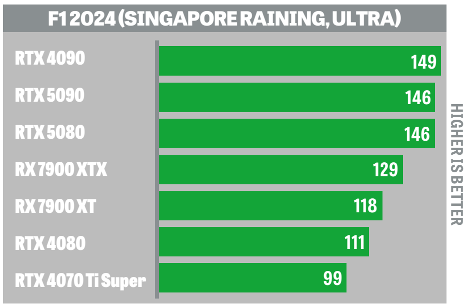
COUNTER-STRIKE 2 (VERY HIGH)



CYBERPUNK 2077 (ULTRA)

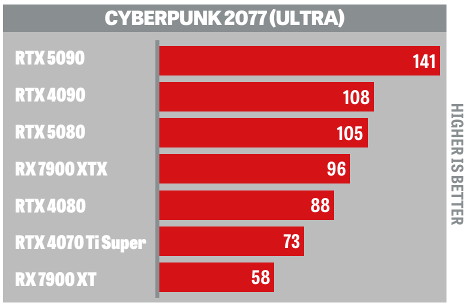


F1 2024 (SINGAPORE RAINING, ULTRA)

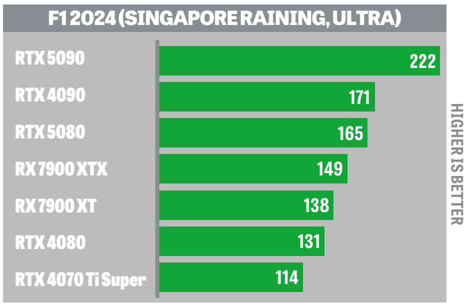


4K GAMING (NO RAY TRACING, BALANCED UPSCALING, FPS)

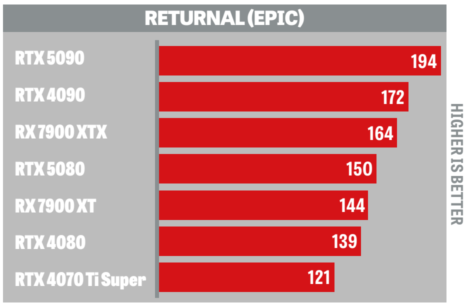
CYBERPUNK 2077 (ULTRA)



F1 2024 (SINGAPORE RAINING, ULTRA)

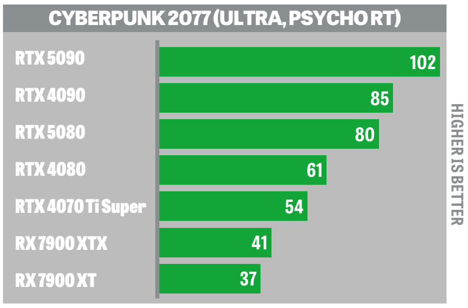


RETURNAL (EPIC)

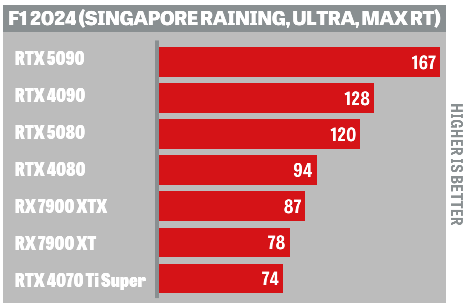


4K GAMING (MAX RAY TRACING, BALANCED UPSCALING, FPS)

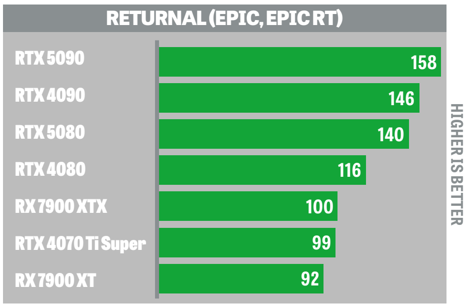
CYBERPUNK 2077 (ULTRA, PSYCHO RT)



F1 2024 (SINGAPORE RAINING, ULTRA, MAX RT)



RETURNAL (EPIC, EPIC RT)



The test rig used an Intel Core i9-14900K on Windows 11 24H2.

DLSS 4 and Flip Metering

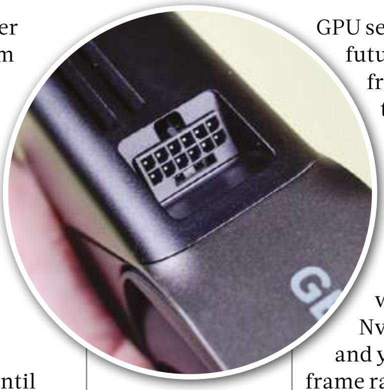
The final hardware piece of the Blackwell puzzle is Flip Metering. This enhanced display engine has twice the pixel-processing capability of its predecessor, and has been designed to take the load away from the CPU when it comes to ordering frames for the display. The Flip Metering feature is there to enable Multi Frame Generation to function smoothly.

DLSS has also had a potentially big upgrade. Previously it used a convolutional neural network (CNN) as the base model for DLSS, which is an image-focused model and made sense for something so image-focused as upscaling. But it's no longer the cutting edge of AI, so DLSS 4 has switched over to the transformer architecture that's familiar from ChatGPT. So far, we've seen little performance difference between the two models, but over time it should lead to higher quality (particularly for ray tracing) and faster frame rates.

We've saved the best new feature for last: Multi Frame Generation. This is arguably the reason to buy Nvidia RTX 50-series cards today, at least until those neural shading features are regularly used in released games.

We are still talking essentially about interpolation, no matter how much Nvidia wants to talk about its GPU seeing four frames into the future. The GPU will render two frames and then squeeze up to three extra frames in between. Using a set of new AI models, it can perform frame generation 40% faster and with a 30% reduction in its VRAM footprint.

Here, you don't need to wait for games. Activate Nvidia's DLSS Override feature, and you can instantly boost your frame rates. To put this into terms of real games, using an RTX 5090 we saw rates of over 180fps in *Alan Wake 2* at max 4K settings, 215fps in *Cyberpunk 2077*'s Overdrive settings and over 300fps in *Dragon Age: The Veilguard.*



ABOVE Power demands have gone up for both the RTX 5080 and 5090

Creative skills

If you're buying either card for 3D rendering then we have excellent news: the RTX 5090 scored between 35% and 49% faster in the Blender tests compared to the RTX 4090, while the RTX 5080 was 15% slower than that far more expensive card.

It's too early to talk about video editing or Photoshop performance as PugetBench for Creators is lagging behind and, at the time of testing, didn't support the new cards. And there was nothing to choose between the AMD or Nvidia cards in Handbrake's 4K to 1080p encoding testing.

While 3DMark is geared towards gamers, it's also a great test for the latest features in graphics cards – particularly more recent additions to the suite such as Steel Nomad. Here, the RTX 5090 was almost 50% faster than the RTX 4090 with a score of 13,932 compared to 9,377, with the RTX 5080 producing an excellent 8,104. Its predecessors, and the fastest AMD cards, trailed in the distance with figures in the mid-6,000s.

Gaming tests

There isn't room to include all the graphs on the previous page, but we tested the RTX 5080 and RTX 5090 in eight games across 1440p and 4K resolutions. The first batch of tests were "straight", with no upscaling and no ray tracing. We then switched ray tracing on, before adding DLSS 3 (rather than DLSS 4) upscaling to keep comparisons based around hardware rather than software.

Under these conditions, there isn't the massive leap that you might hope for after a two-year wait. At 1080p, the RTX 5090 was around 18% faster than the RTX 4090 in non-upscaled gaming, while turning on ray tracing increased that margin to 26%. With upscaling turned on to balanced (but no frame generation) it was 14% faster.

The RTX 5080 again improves on its predecessor (13% better overall, 18% better ray tracing performance), and it actually came within 7% of the RTX 4090 at straight settings. It fell behind again for ray tracing until we switched on balanced upscaling, when it closed the gap to 6% in terms of average frame rate.

But it's at 4K, and switching back to the RTX 5090, where things get juicy. Here, the faster memory and wider memory bus make a telling difference. Without upscaling and with ray tracing turned off, we saw upwards of 200fps for the RTX 5090 on average, compared to the RTX 4090's 154fps average. That's a whopping 30% increase. With DLSS 3 set to balanced, you're looking at a roughly 22% better average frame rate overall compared to the RTX 4090.

With ray tracing and no upscaling, the difference is even more pronounced. The RTX 5090 averaged 34% faster frame rates compared to the RTX 4090. Turn on balanced DLSS 3 with full ray tracing and you're looking at about 22% faster average overall, but a hefty 66% jump if you compare their lowest rates.

Laptops coming soon?

We're still waiting to test laptops with Nvidia's RTX 50-series mobile chips inside, but with systems available to pre-order from 25 February we hope to test a machine or two in next month's issue.

Nvidia will be launching four variants, mirroring the desktop GPUs, but naturally the specs are lower. For example, the mobile RTX 5090 includes 10,496 CUDA cores (shaders) and 24GB of GDDR7 RAM with a 256-bit bus width. Perhaps most tellingly of all, its stated power consumption is a maximum of 90W to 150W depending on the configuration.

All the mobile chips are based on the same Blackwell architecture as their desktop counterparts, and that means support for DLSS 4, plus the latest generation RT cores and tensor cores, so you should be able to switch on ray tracing and enjoy fluid frame rates at the laptop's native resolution. At least, that's the hope. We'll have to wait until we have samples in our hands before we pass final judgement.

ABOVE The Founders Edition cards add understated style to system builds

It's a similar story for the RTX 5080. With no ray tracing or upscaling, the RTX 5080 averaged about 20% faster than the RTX 4080 overall. Its native ray tracing performance is about the same, however.

Should you buy?

Let's not waste words: the RTX 5090 is the best consumer graphics card money can buy. Across all my tests, it provided a 21% boost over the RTX 4090, which is what we'd look for when it comes to gen-on-gen improvement.

That said, we need to talk about power consumption. The 5090 requires 575W, and while Nvidia includes an 8-pin adapter in the RTX 5090 Founders Edition package, most modular PSUs give you three PCIe 8-pin power connectors at most. The upshot: you'll probably need to buy a new ATX 3.0 PSU with at least 1,000W to run this card. While a new fan design does a great job of cooling the GPU – and means the Founders Edition is a dual-slot card rather than triple slot like the RTX 4090 – it's at the expense of turning the card into a space heater. That 575W of heat needs to go somewhere, and that somewhere is inside your PC case.

Although the RTX 5080 offers a more modest improvement, it does so with equally modest power demands: 360W compared to 320W for the RTX 4080 and RTX 4080 Super. What's more, it's at a far lower price than its predecessor. That makes it incredible value for a gaming card – and you won't need to replace your PC's power and cooling system either.

Once you factor in the expected improvements in games once developers roll out updates, and the effect of DLSS Override, the RTX 5080 is the obvious choice for most gamers, while only those who need the absolute best should buy the RTX 5090. **DAVE JAMES, JOHN LOEFFLER**

FEATURE COMPARISON TABLE

	Nvidia RTX 5090	Nvidia RTX 5080	Nvidia RTX 5070 Ti	Nvidia RTX 5070	Nvidia RTX 4090	Nvidia RTX 4080 Super	Nvidia RTX 4080
Starting price at launch	£1,939	£979	£729	£539	£1,699	£959	£1,269
Transistors (billion)	92.2	45.6	45.6	31.1	76.3	45.9	45.9
Compute units	170	84	70	48	128	80	76
Shaders	21,760	10,752	8,960	6,144	16,384	10,240	9,728
AI/matrix cores	680	336	280	152	512	320	304
Ray-tracing cores	170	84	70	48	128	80	76
Render output units	192	128	112	64	176	112	112
Texture-mapping units	680	336	280	192	512	320	304
Boost clock (MHz)	2,407	2,617	2,452	2,512	2,520	2,550	2,505
Memory type	GDDR7	GDDR7	GDDR7	GDDR7	GDDR6X	GDDR6X	GDDR6X
VRAM (GB)	32	16	16	12	24	16	16
VRAM bus width	512	256	256	192	384	256	256
Bandwidth (GB/sec)	1,792	960	896	672	1,010	736	717
TDP (watts)	575	360	300	250	450	320	320

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Scan 3XS Edge iCue

Silent but deadly fast, this is a high-class gaming PC that also has plenty to offer creative workers

SCORE ★★★★★

PRICE £2,333 (£2,800 inc VAT)
from scan.co.uk

The line between gaming PCs and creative workstations has never been slimmer, and the Scan 3XS Edge iCue sits bang on it. Switch the fans to white using the Corsair iCue software that gives this PC its name and you have a stylish, understated workstation; choose the Interstellar profile instead and you'll be bombarded with distracting flashing colours to set a gamer's heart pulsing.

But Nvidia's GeForce RTX 5080 GPU defines this PC. As we cover on the previous pages, this is the second release in Nvidia's long-awaited RTX 50-series, and while the RTX 5080 is significantly less powerful than the RTX 5090, it represents far better value for money – and has the advantage that you can buy one. RTX 5090 cards are scarcer than "Biden for President" bumper stickers.

Scan is not alone in focusing on the RTX 5080. If you turn the page, you'll find two more PCs featuring an RTX 5080 card. The CyberPowerPC Infinity Z890 Elite PC is based around Intel's Core Ultra 9 285K processor, while Wired2Fire opts for the Ryzen 7 9800X3D in its R7X3D RTX 5080 Beast – the same chip that Scan settled on.

Choice processor

The AMD Ryzen 7 9800X3D is the current gaming king, with its eight powerful Zen 5 cores and 96MB of Level 3 cache proving to be the perfect partner for powerful graphics cards. I admit this isn't obvious based on the tiny sample size of four games in the graphs opposite, but if you read our head-to-head review of the 9800X3D and Intel's Core Ultra 200K series (*see issue 364, p58*) you'll see that AMD wins in most titles.

This is nuanced, however. The extra cache shows its value in games where data such as texture files and model geometry must be held in the fastest possible memory, and in our standalone CPU tests that was particularly true for *F1 2023* (where the 9800X3D returned 551fps at 1080p to the Core Ultra 9 285K's 403fps) and *Tiny Tina's Wonderlands* (594fps at 1080p versus 478fps). Switch to games where the CPU must calculate, say, complex bullet physics and the advantage falls to Intel: in *Returnal* at 1080p, the 285K averaged 244fps to 227fps for the 9800X3D.

The Core Ultra 9 285K has 16 efficient-cores (E-cores) to accompany eight performance-cores (P-cores), which is why PCs based on it sit atop our Geekbench 6 multicore table opposite. However, it's testament to the power of AMD's Zen 5 cores that it more than holds its own: the Scan 3XS Edge iCue may sit at the bottom of that graph but its score of 18,198 is only a few percentage points behind the 20,374 of the CyberPowerPC Infinity Z890.

Rumours suggest AMD's 12-core Ryzen 9 9900X3D and 16-core Ryzen 9 9950X3D will go on sale in late March, to tie in with the launch of AMD's RX 9070 and RX 9070 XT cards. However, neither of those new CPUs will be cheap.

GPU power

Scan chooses Asus for both its motherboard and its GPU, which makes sense as Asus has a reputation for both the quality and speed of its components. Scan offers the most generous warranty of the three system providers here, with three years of cover that includes both parts and labour (although you'll have to pay courier costs to Scan for the second and third years).

As the "OC" in the graphics card's full name indicates, it's overclockable above Nvidia's standard settings. As supplied, Scan overclocks the core by 300MHz and the memory by 500MHz, and it pre-installs MSI's highly respected Afterburner app if you wish to experiment.

Despite this overclock, it was always one to five frames per second behind the Wired2Fire PC – which has the same core components – in our tests. So, if extracting every last ounce of juice from the RTX 5080 and Ryzen 7 9800X3D is vital to you, then that's the system to buy.

However, what's impressive about the Scan system is that it achieves its roaring speeds with barely a whimper from the fans. They run at an inaudible 350rpm at idle, but even at peak they only reach 1,400rpm. There are six installed, all RGB, yet I almost had to place my ear next to this PC to hear them. Likewise the Corsair liquid cooler rarely makes a sound, while lesser units have the habit of glugging noisily.

> "What's impressive about the Scan system is that it achieves its roaring speeds with barely a whimper from the fans"

Corsair lines

Scan again chooses Corsair for its chassis, giving a UK debut to the Corsair Frame 4000D. As supplied, it's a standard but high-quality mid-tower chassis finished in matte black. There's a large, tempered glass side and plenty of room to work within, despite the considerable length of the Asus graphics card.

But there's a reason why Corsair describes this as a modular case. Not merely due to the adjustable rail that makes it easy to switch between fan sizes, nor the support for dual 360mm radiators in the front, roof and side. Not even the ability to swap out the honeycomb front for one of three other designs that Corsair sells. Wait until this summer, and you can buy

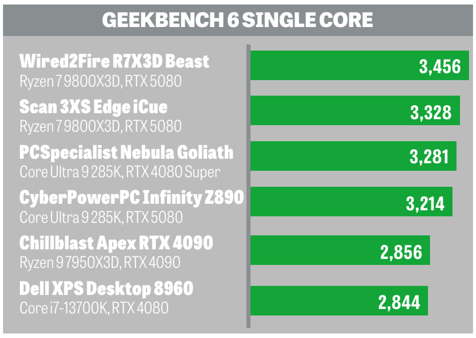
CORSAIR
3XS
ASUS
GEFORCE RTX
CORSAIR

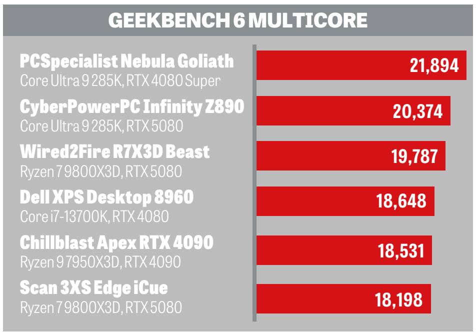
ABOVE The Edge iCue is a ridiculously quiet, powerful PC based on the RTX 5080 GPU

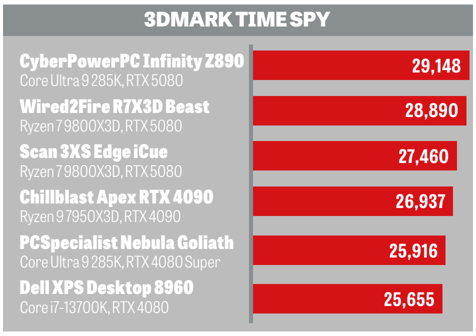
PC PRO ★★★★★ A-LIST

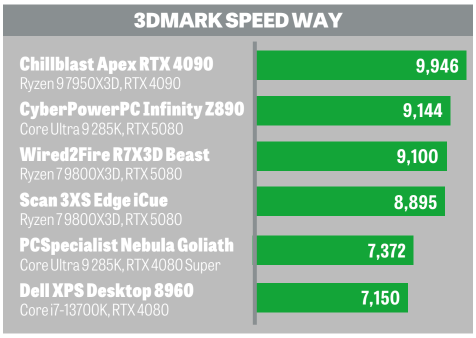
CORSAIR
3XS
ASUS
GEFORCE RTX

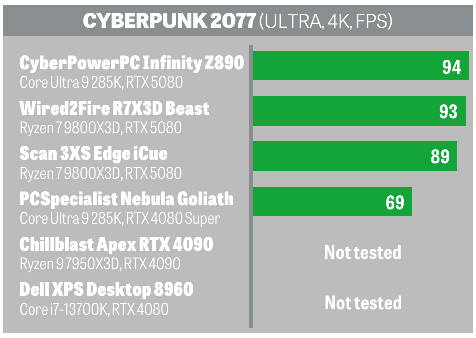
LEFT The fan lights can be switched from an understated white to a multicoloured, flashing extravaganza

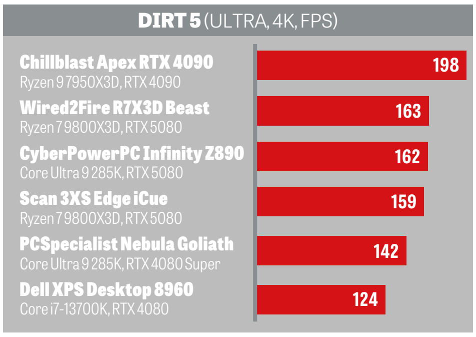


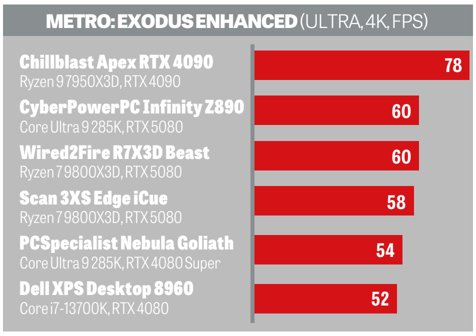


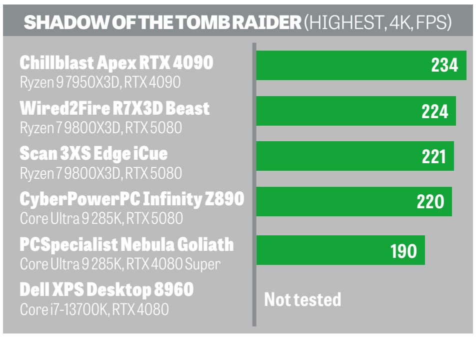












the 14.5in Corsair Xeneon Edge touchscreen display for $249 (we don't have UK prices yet), which Windows will detect as a second screen. Obvious uses include displaying thermal and fan information, but why stop there?

Scan also opts for Corsair RGB DDR5-6000 memory, filling two of the four sockets for a 32GB total. With one of the three M.2 sockets on the Asus TUF Gaming B650-Plus WiFi motherboard supporting PCIe 5, Scan could have lavished money on one of the latest-generation SSDs, but sensibly opts instead for a Gen4 2TB Western Digital SN770 drive. It's not the fastest around, with sustained read and write speeds of 5,225MB/sec and 4,827MB/sec in CrystalDiskMark, but it's incredibly rare that this will cause a bottleneck.

Motherboard choice

As its name suggests, the TUF Gaming B650-Plus motherboard is geared towards gamers rather than creatives. That's largely dictated by the B650 chipset, which loses high-end features you'll find in chipsets such as the X870 in the Wired2Fire system. In particular, there's no PCIe 5 support to match the graphics card, which means there might be the very odd occasion when the 32GB/sec bus is saturated – but I would consider PCIe 5 as a nice-to-have for the RTX 5080 rather than the must-have it becomes for the memory-rich RTX 5090.

You still enjoy support for 2.5GbE on the B650 chipset and there are lots of USB ports for adding external storage. There's no Thunderbolt support, nor USB-C 4, but it's good to see a 20Gbits/sec USB-C 3.2 Gen 2x2 port, along with one USB-C 3.2 Gen 2 port (10Gbits/sec) and two USB-A 3.2 Gen 2 ports. Four USB-A 2 ports complete the rear portfolio. The front-mounted ports are stuck at USB 3.2 Gen 1 (5Gbits/sec), with one USB-C and two USB-A connectors.

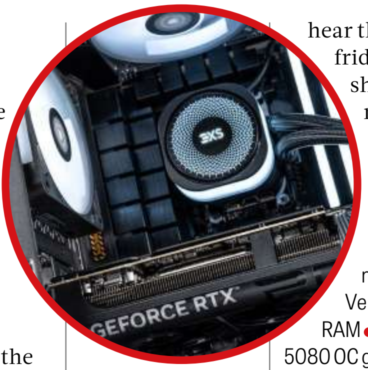
Wireless connections are restricted to Wi-Fi 6 and Bluetooth 5.2, so you may choose to fill the single accessible PCIe 4 x1 slot with an adapter card. That still leaves a PCIe 4 x16 slot at the bottom of the board. And you won't even need to remove the graphics card to access them.

Room to play

There are a few nice extras that Scan offers with its high-end systems. For £50, you can choose to join Scan engineers as they build your system in its Bolton HQ (up to two people; this is popular with parents and kids, Scan told me), or join in the build remotely where you can chat to engineers as they work on your system. Or, for free, there's a live stream option on Discord where you can simply sit back and watch.

Scan also offers an etching service on the tempered glass side panel, which normally costs £30 – you simply send in the image you want etched – but with this system Scan is offering it for free. These extras are one of the many reasons the company always does so well in our annual service and reliability survey.

But the reason I would choose the Scan 3XS Edge iCue over its rivals, despite their superior performance in benchmarks, is that this PC is so ludicrously quiet. I'm sitting writing these words with the Edge sitting right next to me on my desk, yet I can hear the noise from my under-desk fridge more clearly. It's nothing short of an engineering miracle. **TIM DANTON**



ABOVE The GeForce RTX 5080 provides plenty of oomph for gamers and creatives

SPECIFICATIONS

8-core/16-thread AMD Ryzen 7 9800X3D processor ● Asus TUF Gaming B650-Plus WiFi motherboard ● 32GB Corsair Vengeance RGB Grey DDR5-6000 RAM ● 16GB Asus Prime GeForce RTX 5080 OC graphics ● Corsair iCue Link Titan 240 Liquid Cooler ● 2TB Western Digital SN770 PCIe Gen 4 SSD ● Corsair Frame 4000D chassis ● 850W Corsair RMe Series Gold PSU ● Windows 11 Home ● 239 x 490 x 486mm (WDH) ● 3yr warranty (1yr on-site, 2yr RTB, parts and labour) ● power: 82W idle, 464W peak

Wired2Fire R7X3D RTX 5080 Beast Gaming PC

This truly is a beast, being the best-specified and fastest RTX 5080 PC on test, but also the noisiest

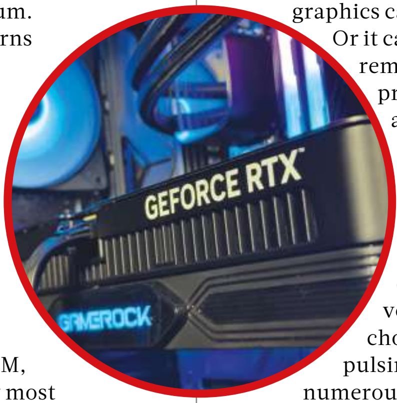
SCORE ★★★★☆

PRICE £2,333 (£2,800 inc VAT)
from wired2fire.co.uk

ABOVE **Beast by name, beast by nature: this Wired2Fire PC is a real animal**

In some ways, the Wired2Fire Beast (we don't have space to spell out its full name) is the polar opposite of the Scan 3XS Edge iCue (*see p50*), despite the two sharing the same GPU, CPU and price. Where the Scan is an ice queen, silent and aloof, the Beast lives up to its name with a domineering design, lashings of RGB colour and an ever-present low hum.

The Beast also earns bragging rights by topping our performance table – if we limit ourselves to the trio of RTX 5080 systems on test this month – more times than either of its rivals. With the help of 64GB of top-quality XPG RAM, it squeezed the very most out of the Ryzen 7 9800X3D by returning 19,787 in Geekbench 6's multicore test; that's a few hundred behind the CyberPowerPC's 20,374, but an impressive return for an 8-core chip up against the 24-core Core Ultra 9 285K. Admittedly, Cinebench 2024 brought it back down with a bump, with its 1,431 score in the multicore section trounced by the 2,290 from its rival.



LEFT **The PC wrings every last frame out of the RTX 5080 graphics**

Wired2Fire's system is also a great choice if you want to wring every last frame possible out of the graphics card, staying 1-5fps ahead of the Scan at 4K in all of our gaming benchmarks. Likewise in the four 3DMark tests I put these systems through, where it was typically around 5% faster than its rival (for instance, it returned 22,515 in Port Royal compared to 21,817 for the 3XS Edge). But that was also reflected in their power consumption, with the Beast demanding 102W at idle and 662W at peak, compared to 82W and 464W for the Scan.

But I can't hide from talking about the case any longer, because the Be Quiet Light Base 600 LX is quite something to behold. The feet are detachable via a simple twist, which means it can stand as supplied or upside down (there's plenty of support for the graphics card either way). Or it can sit on its side, reminding me of a 3D printer crossed with a 1980s hi-fi. You control the RGB lighting strips via a button on the front, just above a USB-C port if the chassis is sitting vertically, with a choice of solid or pulsing patterns and numerous colours. You'll find something you like, I'm sure.

This button also controls the RGB lights on four of the seven fans. The remaining three fans – which are mounted at the top of the case in its standard tower orientation – memory and graphics card logo are controlled by Gigabyte's software instead. Luckily, it's easy to match the two up. The software accompanies the Gigabyte X870 Eagle WiFi 7 motherboard Wired2Fire places at the heart of this system, a forward-thinking choice thanks to its support for PCIe Gen 5 for both the graphics card (although the RTX 5080 will only rarely, if ever, take advantage) and one of its three M.2 slots. You also benefit from two full-length PCIe 3 x1 slots, and thanks to the motherboard design and sheer size of the case, it's easy to access these.

Remove the right-hand side and you'll discover neat hideaways for two 3.5in hard disks and a pair of 2.5in SATA drives, plus the 1,000W Corsair RMe PSU and a rat's nest of wires and braided cables. Luckily you won't need to worry about the latter unless you decide to supplement the supplied 2TB SSD, a fast Kingston Fury Renegade unit that matched its name with sustained read and write speeds of 7,367MB/sec and 6,832MB/sec respectively.

PC PRO RECOMMENDED

> **"It's undeniably excellent value: you're getting twice as much memory as the Scan, faster performance and a longer five-year warranty"**

I'm left with mixed feelings about the Wired2Fire Beast. It's undeniably excellent value: you're getting twice as much memory as the Scan, faster performance and a longer five-year warranty. But it also consumes more electricity and more space, and even when I set the fan profile to Silent using Gigabyte's software there was a constant (albeit never irritating) hum. Play games and it becomes a noisy beast, too. This is where personal taste comes into play, as many people don't care about this level of fan noise and will far prefer the Beast's styling to the more conventional and – let's face it – duller Scan. If that's you, you won't regret investing your money in this cutting-edge PC. **TIM DANTON**

BELOW **The versatile Be Quiet chassis is something to behold**

SPECIFICATIONS

8-core/16-thread AMD Ryzen 7 9800X3D processor ● Gigabyte X870 Eagle WiFi 7 motherboard ● 64GB XPG Lancer Blade DDR5-6000 RAM ● 16GB Gamerock GeForce RTX 5080 graphics ● Wired2Fire Beast 360mm AIO Liquid Cooler ● 2TB Kingston Fury Renegade PCIe Gen 4 SSD ● Be Quiet Light Base 600 LX chassis ● 1,000W Corsair RMe Series Gold PSU ● Windows 11 Home ● 450 x 305 x 455mm (WDH) ● 5yr warranty (2yr C&R, 3yr parts and labour) ● power: 102W idle, 662W peak

CyberPowerPC Infinity Z890 Elite PC

A fast performer and excellent choice if you'll take advantage of the Core Ultra 9 285K processor

SCORE ★★★★★

PRICE £2,499 (£2,999 inc VAT) from tinyurl.com/367cyberpower

ABOVE The Infinity Z890 Elite is a fine advert for Intel's Core Ultra 9 285K CPU

CyberPowerPC takes a different approach to Scan and Wired2Fire, partnering its GeForce RTX 5080 graphics card with an Intel Core Ultra 9 285K processor. While Intel's Arrow Lake desktop CPUs haven't set the world alight, there is much to like about this flagship of the range. Not least its eight P-cores and 16 E-cores, which thrive on multicore tasks.

This showed itself in Geekbench, where its result of 20,374 was around 10% faster than the Scan and a few hundred points in front of the Wired2Fire. And that lead became much clearer in Cinebench 2024, with a 2,290 result around 30% ahead of its rivals. Not that it was a winner-takes-all situation: I also benchmarked all three systems using PCMark 10, and here the AMD-powered units were fractionally ahead. Still, what matters is that this is a blisteringly fast system.

LEFT A Be Quiet Dark Rock cooler helps keep temperatures down

Naturally, that extends to games. As the photo reveals, the MSI Suprim OC card dominates the interior of the chassis, with gigantic radiators sucking away the heat. And to great effect, with the CyberPowerPC system duking it out for top spot with Wired2Fire throughout our gaming tests.

All these results were at the system's performance fan settings, and that means noise. Not quite as much as the Wired2Fire, but enough that you can't ignore it when sitting on a desk. Fortunately, if you load up MSI Center – and download the relevant modules – then you can control fan noise based on scenarios (Extreme Performance, Balanced, Silent) or let MSI's AI Engine take charge. Dig deeper and you can add apps to scenarios of gaming, work, meeting and entertainment, so that the PC knows to cut fan noise during a Zoom call, for instance.

With the fans under control, the Infinity Z890 Elite becomes a fantastic desk companion, even if its fan noise remained higher than the ultra-chill Scan. The Lian Li Lancool 207 chassis is the most compact here, and the two RGB front fans add visual impact behind the metal grille at the front. Aside from the single rear fan, the only other RGB of note stems from the pair of 16GB Kingston Fury Beast DDR5-6000 DIMMs. These are partially blocked by the fan blowing air onto a Be Quiet Dark Rock Pro 5 cooler that reflects both parts of its name.

BELOW The compact chassis is brightened up by two RGB fans

Working inside the case is going to be impossible unless you remove the graphics card, but a single button press unlocks the slot so this isn't a horrendous task. This also opens up access to the single available PCIe x16 Gen 4 slot. Not that there's anything obvious missing from the gamer-orientated MSI MAG Z890 Tomahawk Wi-Fi motherboard, with two rear Thunderbolt 4 ports, RAID support, 5GbE LAN and Wi-Fi 7. That's on top of seven USB-A ports plus one USB-C port, and four of those (including the USB-C port) support USB 3.2 Gen 2 for 10Gbits/sec transfers. The front-mounted USB-C port goes even further, with support for USB 3.2 Gen 2x2 (20Gbits/sec).

There are four M.2 sockets, all covered by MSI's heatsinks and, like the graphics card, removable by a single button push. One M.2 socket supports PCIe Gen 5, but CyberPowerPC keeps costs under control by choosing a 2TB Kingston Fury Renegade Gen 4 SSD. This returned 7,021MB/sec sustained read speeds and 6,702MB/sec writes in CrystalDiskMark 8, so it's fast. As a side note, the graphics card's slot also supports PCIe Gen 5, which you may be grateful for when it's time to upgrade.

PC PRO RECOMMENDED

> "With a five-year warranty and so much quality, I find it hard to fault what CyberPowerPC is offering. It's a great choice"

Finally, we need to talk about price. It isn't a coincidence that this PC costs around £200 more than its rivals this month: not only is Intel's Core Ultra 9 285K processor more expensive than the Ryzen 7 9800X3D, but so is the Intel Z890 motherboard required to support it. Right now, that's the premium you're paying for Intel's top-end consumer CPU, which also includes Intel's first-generation NPU. This isn't powerful enough to qualify for Copilot+ PC status, but might occasionally come in useful.

With a five-year warranty and so much quality, I find it hard to fault what CyberPowerPC is offering. If you want Intel, or simply know that its higher core count will benefit your workflow over the more gaming-focused Ryzen 7 9800X3D, then it's a great choice that's worth the £200 extra. **TIM DANTON**

SPECIFICATIONS

24-core (8 P-cores, 16 E-cores) Intel Core Ultra 9 285K processor ● MSI MAG Z890 Tomahawk Wi-Fi motherboard ● 32GB Kingston Fury Beast RGB DDR5-6000 RAM ● 16GB MSI Suprim GeForce RTX 5080 OC graphics ● Be Quiet Dark Rock Pro 5 air cooler ● 2TB Kingston Fury Renegade PCIe Gen 4 SSD ● Lian Li Lancool 207 chassis ● MSI MAG A1000GL 80 Plus Gold PSU ● Windows 11 Home ● 219 x 456 x 456mm (WDH) ● 5yr warranty (1yr C&R, 2yr parts) ● power: 63W idle, 589W peak

3XS SYSTEMS PRO GRAPHICS

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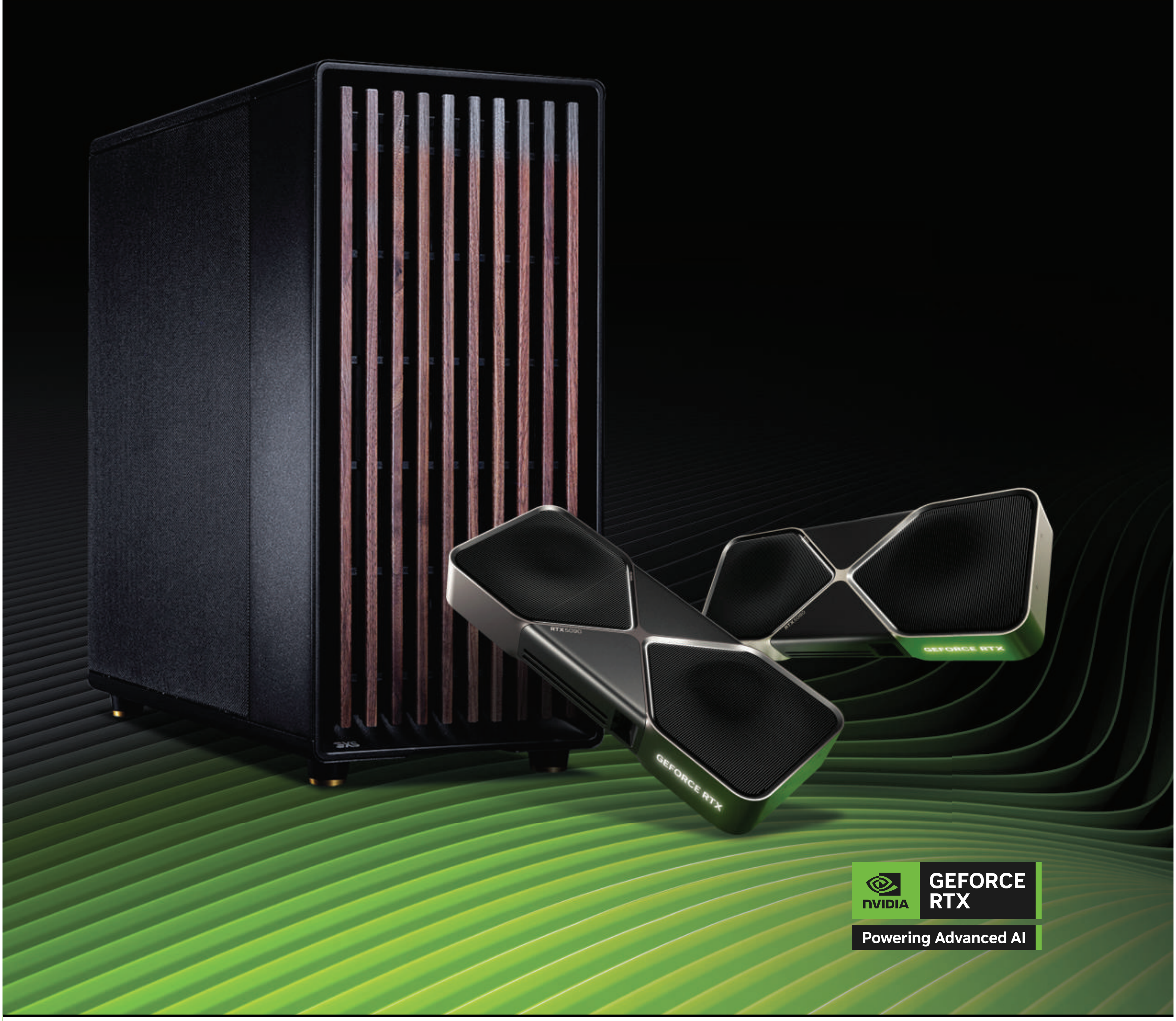
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*NVIDIA GeForce RTX 5090 vs NVIDIA GeForce RTX 4090

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SCAN

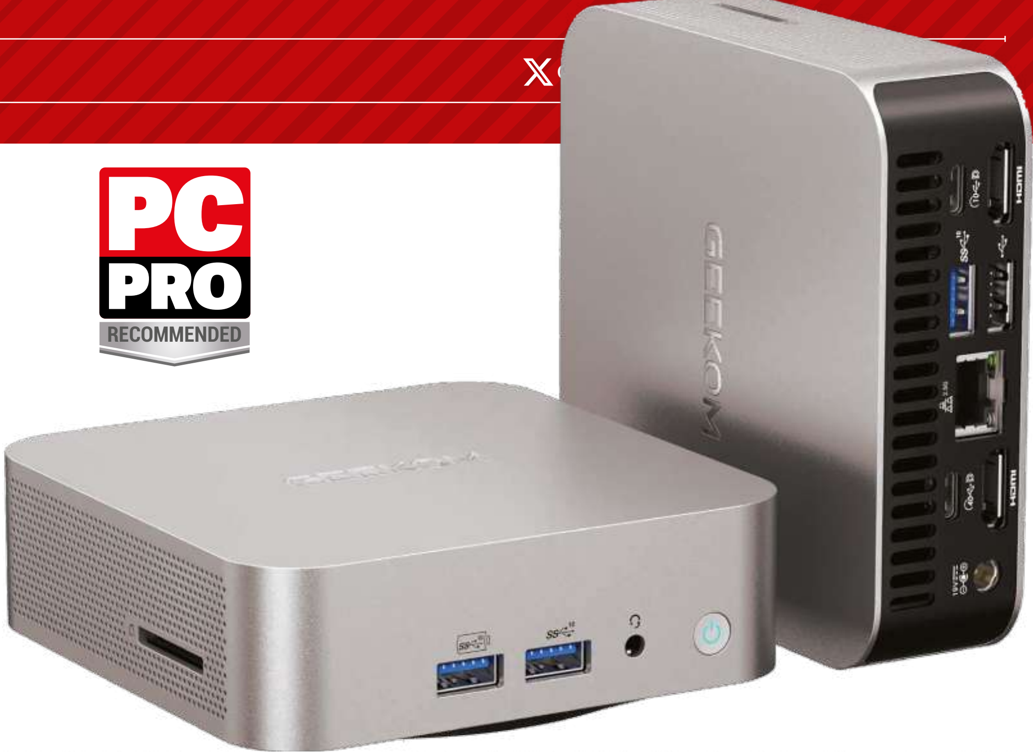
Geekom A6 Mini PC

This high-quality mini PC offers excellent value versus the Geekom A8 and pushes our A List choice close

SCORE ★★★★★

PRICE £416 (£499 inc VAT)
from geekom.co.uk

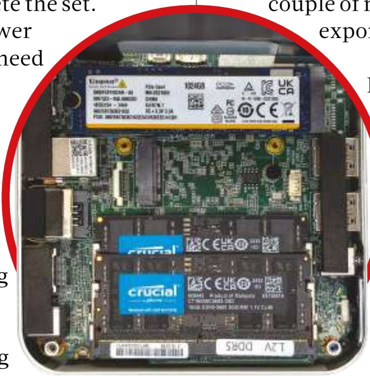
PC PRO RECOMMENDED



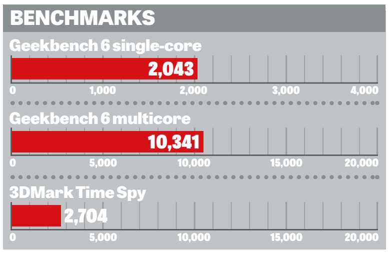
When I spoke to Geekom at CES, the A6 proved to be the hot topic. While the A8 (*see issue 363, p85*) is popular thanks to its incredibly small footprint and 0.47-litre volume, not to mention its stylish aluminium alloy frame, many potential Geekom customers wanted a cheaper option. Something closer in price to the £535 Minisforum Venus UM790 Pro (*see issue 363, p91*), which won our recent mini PCs Labs.

The A6, then, is Geekom's answer. With a selling price of £499 (I'll ignore the £599 list price), it's £220 cheaper than the A8 despite using the exact same chassis. That means two USB-A 3.2 Gen 2 ports on the front alongside the 3.5mm combo jack and power switch, a full-size SD card slot on one side and the majority of ports tucked away at the rear. Highlights include two USB-C ports, both of which can be used to output to displays, plus a pair of HDMI 2.0 connectors – this tiny PC can output to four 4K monitors at once. A single 2.5GbE port and trio of USB-A ports complete the set.

There's also a power input, which you'll need because, unlike the Minisforum, you can't power the A6 via its USB-C ports. So you'll also need to accommodate its 98 x 64 x 22mm power brick, making this a less attractive option than the UM790 for mounting behind a monitor, despite the VESA mount in the box.



So far, so much like the A8. In which case, how has Geekom shaved £220 from the price? The answer is by choosing AMD's older Ryzen 7 6800H rather than the Ryzen 9 8945HS inside the A8 (the UM790 includes a Ryzen 9 7940HS). While the 6800H still delivers eight performance cores and 16 threads, they're based on AMD's Zen 3+ generation rather than the Zen 4 cores in the 8945HS and 7940HS. Nor do you get any form of NPU (although none of these chips meets Microsoft's Copilot+ PC criteria).



In raw benchmark terms, that means the A6 is around 20% slower in both Geekbench 6's single-core test (2,043 versus 2,640 for the A8) and multicore test (10,341 versus 13,348). It's a similar story compared to the UM790, which was 25% and 15% faster respectively. Still, in most daily tasks the Geekom A6 is incredibly responsive, and so what if it takes a couple of minutes longer to export a video?

None of these mini PCs is a natural choice for gamers, but the A8's 3D acceleration is superior, with a 3,215 return in 3DMark Time Spy compared to 2,984 for the UM790 and 2,704 for the A6. In *Shadow of the Tomb Raider* at 1080p, that translated into an average of 63fps for the A8 at lowest settings, while the UM790 returned 58fps and the A6 55fps.

One test where the A6 beat its rivals was for power consumption, barely topping 6W at idle and hitting a peak of 77W. The A8's figures were 8W and 95W, the UM790 required 6W and 81W. Admittedly, even over a five-year period, that doesn't convert into anything you'll notice in your pocket: based on eight hours of use, the A6 would cost you £53, the A8 £68 and the UM790 £55.

ABOVE The A6 Mini PC is a great affordable alternative to Geekom's popular A8

LEFT The two 16GB DIMMs and 1TB SSD are all replaceable

What you will notice is the lack of noise the A6 makes, with barely a murmur at idle and only rising to a proper whoosh when pushed. You'll definitely notice the noise at this point, but they aren't whiny fans so hopefully they won't annoy.

All the price comparisons I've mentioned are for the 32GB/1TB combinations of these mini PCs, and that's the only model of the A6 currently on sale in the UK. While you could replace the supplied 1TB SSD yourself – it's medium pace, with 4,058MB/sec sustained reads and 3,658MB/sec writes – there's no room in this tiny chassis for a second SSD (there is in the UM790). You also need to be careful when working inside as it's so easy to detach the wireless antenna. I did this during my tests, but the Wi-Fi 6E connection still worked.

> **"In most daily tasks the Geekom A6 is incredibly responsive, and so what if it takes a couple of minutes longer to export a video?"**

So, should you buy the Geekom A6 or the A8? That really boils down to whether you'll notice the power difference between them in your daily life. However, the UM790 retains its top position in our A List because of its potent mix of speed and value, even though the A6 wins for build quality and size – and for including Windows 11 Pro. If the A6 could have been powered over one of its USB-C sockets then I might have been persuaded to put it into top position, but it's a close second instead. **TIM DANTON**

SPECIFICATIONS

8-core/16-thread AMD Ryzen 7 6800H processor ● 32GB DDR5-5600 RAM ● AMD Radeon 680M graphics ● 1TB M.2 NVMe PCIe Gen 4 SSD ● SD card reader ● Wi-Fi 6E ● Bluetooth 5.2 ● 2.5GbE port ● 2 x HDMI 2.0 ● USB-C 4 ● USB-C 3.2 Gen 2 ● 3 x USB-A 2 ● USB-A 2 ● 3.5mm jack ● 37 x 112 x 112mm (WDH) ● 437g ● Windows 11 Pro ● 3yr RTB warranty

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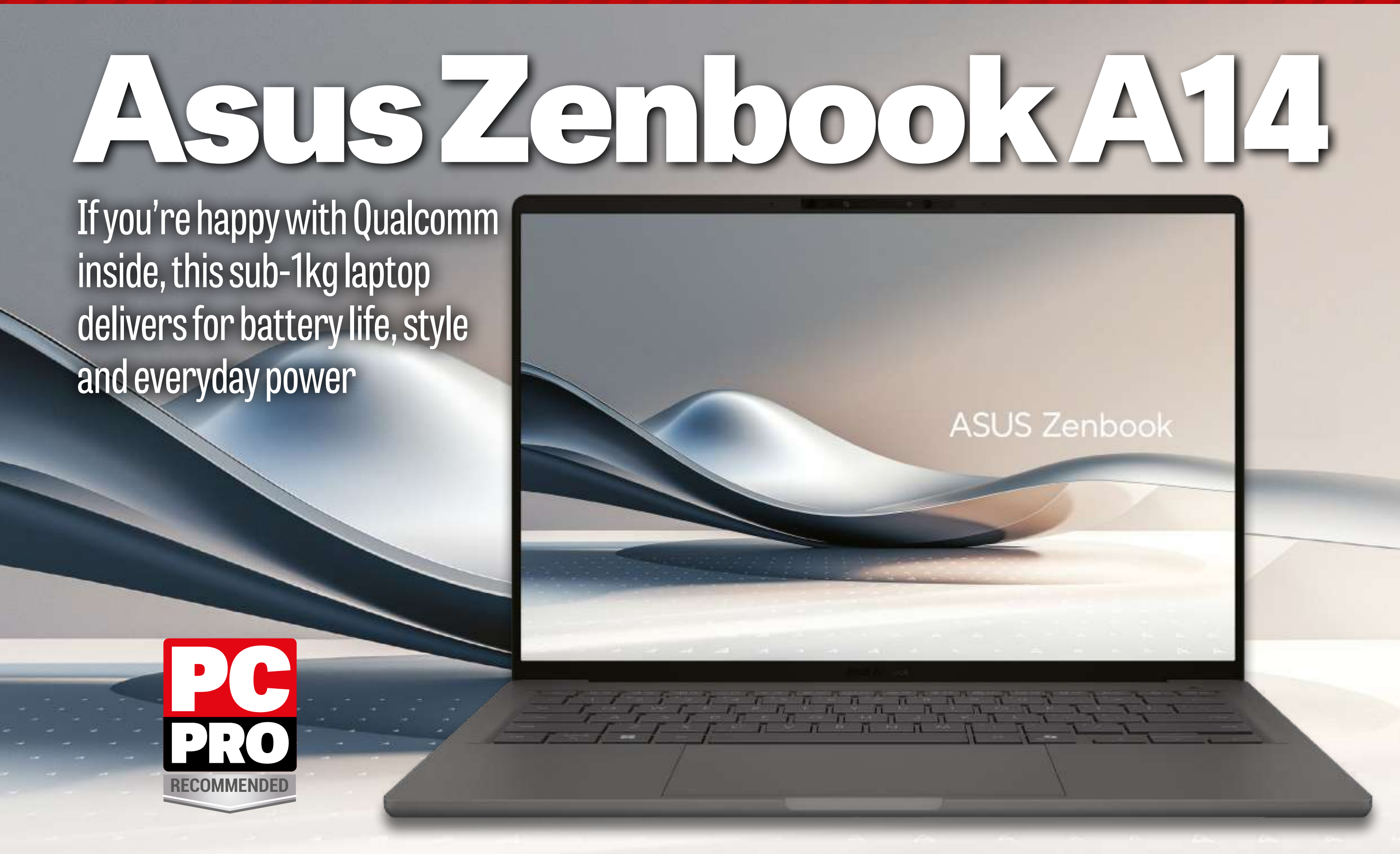


PC PRO RECOMMENDED

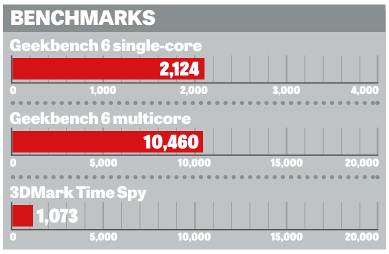
ABOVE **The Zenbook A14 really does redefine what you can expect for this price**

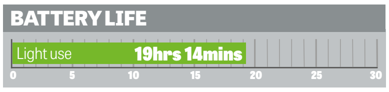
SCORE ★★★★★

PRICE £917 (£1,100 inc VAT) from uk.store.asus.com

Companies often exaggerate in their marketing: we're rewriting the rules, revolutionising the world, solving all of humanity's problems. But this laptop is worthy of hyperbole, because it has reset my expectations of what you can buy for £1,100.

For a start, the Zenbook A14 is unusually light. 980g, to be exact. I can't think of a laptop that's weighed so little that could be bought for under £1,500 before. Then there's the fact that it includes a top-quality OLED panel, which again used to be a premium feature. And finally there's its sheer style.





Asus calls the material "Ceraluminium", and this is no spray-on coating. According to Asus, it's a "ceramic oxidised material that grows directly from the aluminium itself", and the result is a soft-feel metal that should keep looking good for years to come. Scratches won't reveal metal, for example, because the oxidised material is integrated.

Personally, I like the earthy green tones of the Zenbook A14, in part because it's so different from the dull industrial greys we see elsewhere. Couple that with this laptop's tiny physique and you will gain many admiring glances if you buy this laptop.

ABOVE **At just 980g, this is a supremely portable machine**

The power sacrifice

There's no way that you can spend so much on these areas without making sacrifices at this price, so the question comes whether they're in places that matter for you. First off, the processor. This is a debut for Qualcomm's Snapdragon X, announced at CES, which features eight 2.96GHz cores – significantly slower than the 3.42GHz X Plus chips that sit just above it in the Snapdragon range.

That's reflected in this laptop's benchmark scores, with 2,124 and 94 in the single-core sections of Geekbench 6 and Cinebench 2024 respectively. Compare that to 2,457 and 108 for the X Plus-powered Acer Swift 14 AI Qualcomm (*see p60*). It's the same story in the multicore tests, with the Zenbook scoring 10,460 and 699 while the Swift 14 returned 13,295 and 789.

There's even more water between the two when it comes to graphics power, with the Zenbook scrabbling to 1,073 in 3DMark Time Spy and the Swift almost doubling that to 1,905. These results were mirrored in my gaming tests, with the Zenbook on 18fps in Dirt 5 (low settings, 1200p) while the Swift AI achieved 30fps.

The one feature Qualcomm will never cut from its Snapdragon chips is the NPU, as that is its big selling point over AMD and Intel. Every single one of its range includes the identical 45 TOPS neural processor, bringing with it support for Copilot+ PC

> **"It's a great choice for watching films or viewing photos, with 99% coverage of the DCI-P3 space and excellent colour accuracy"**

status. Incidentally, Asus claims this is the lightest Copilot+ PC in the world.

Bright thinking

Another sacrifice comes via the screen's resolution (and 60Hz refresh rate). At 1,920 x 1,200, you can work on two windows side by side, but it's a squash. I found myself with one window stretching two-thirds across the screen and another slim window by its side with reference material. Text still looks sharp, though, and whites are strong so long as you push the brightness above the halfway mark – it reaches 394cd/m², which is plenty for OLED panels as they're more readable at lower brightness levels than IPS screens.

It's a great choice for watching films or viewing photos, with 99% coverage of the DCI-P3 space and excellent colour accuracy (the average Delta E is 0.4). You can also use the comprehensive MyAsus software to switch between colour profiles, and I recommend you do so. The default is fine, but you may discover that you prefer sRGB for purer whites or Display P3 for a wider set of colours. The latter is my preference.

Anyone using this laptop for video calls will be similarly rewarded by checking the AI noise-cancelling settings. It's on multi-presenter mode by default, but I found the single-presenter mode produced the best results; it was excellent at removing the low whirr of my desktop PC's fans. Video quality is the same high standard, with the NPU on call to enhance the image or add background blur.

I'm less enamoured by the speakers, which mangled Fleetwood Mac's "Tusk" to such an extent that the drums sounded like Mick was hitting bin lids. It copes better with less bass-heavy tracks, but I wouldn't listen to my favourite albums on this laptop.

Slim but mighty

Asus has done a much better job with the keyboard. While there isn't much cushioning, there's plenty of travel on the well-spaced keys, while separated cursor keys are easy to find. I enjoyed using the smooth and generously sized touchpad, too: it isn't haptic, but sliding a finger up and down the left-hand side controls the volume and the right-hand side the brightness.

The port selection is predictable for a Snapdragon system, with a combo jack, two USB-C 4 ports and HDMI 2.1 connector sitting on the left. Impressively, these can output to three monitors simultaneously. Head to the right and you'll find a sole USB-A port, but at least it supports USB 3.2 Gen 2 and thus 10Gbits/sec transfers. One final note: Wi-Fi is limited to 6E rather than Wi-Fi 7.

ABOVE The selection of ports includes two USB-C 4 and an HDMI 2.1 connector

Then we come to arguably the most important feature of all, battery life. After removing a frankly unnecessary ten Torx T5 screws, I was relieved to find a chunky 70Wh battery in place. This explained how such a tiny laptop was able to survive almost 20 hours of video playback in my tests, despite the presence of an OLED panel. My other discovery was that the supplied 1TB of storage – another area where Asus hasn't skimped, with the Micron drive returning excellent sustained read and write speeds of 7,006MB/sec and 6,114MB/sec respectively – is user replaceable. At which point I'll draw your attention to the skimpy single-year warranty.

> "A chunky 70Wh battery explains how such a tiny laptop was able to survive almost 20 hours of video playback in my tests"

Overall triumph

While I have my criticisms of the Asus Zenbook A14, none of them would stop me recommending it to a friend. Not only is it light to hold, it's light on the wallet, too. You won't enjoy cutting-edge speeds, but in general use I couldn't tell the difference between using this and a higher-specced Qualcomm system. And if you enjoy playing the latest games on your laptop, Snapdragon/Arm isn't the right platform to choose anyway.

All of which means this is a great laptop for anyone whose priority is mobility. It undercuts its sub-1kg rivals by several hundred pounds, looks (and feels) fantastic, and the battery life is more than enough to keep you going for a day away from the mains. **TIM DANTON**

SPECIFICATIONS

8-core Qualcomm Snapdragon X1-26-100 SoC ● Qualcomm Adreno graphics ● 16GB LPDDR5X-8448 RAM ● 14in 60Hz OLED non-touch panel, 1,920 x 1,200 resolution ● 1TB M.2 PCI-E Gen4 SSD ● Wi-Fi 6E ● Bluetooth 5.3 ● 1080p IR webcam ● 2 x USB-C 4 ● USB-A 3.2 Gen 2 ● HDMI 2.1 ● 3.5mm combo jack ● 70Wh battery ● Windows 11 Home ● 311 x 214 x 13.4-15.9mm (WDH) ● 980g ● 1yr RTB warranty

LIVING WITH QUALCOMM CHIPS

Snapdragon
X

Nine months ago, Microsoft tore down the silicon fence it had been sitting on by announcing that Copilot+ PCs would launch exclusively on Qualcomm's Snapdragon chips. At the time, these were the only processors that supported the 40 TOPS minimum criterion required to take advantage of the promised AI skills.

This move marked an inflexion point in Microsoft and Qualcomm's long-running partnership to adapt Windows for the Arm architecture. On one side, Qualcomm is working hard with software developers to create Arm-native versions of their Windows apps. On the other, it's collaborating with Microsoft on its Prism emulation software. To quote Microsoft: "[Prism is] a software simulator, just-in-time compiling blocks of x86 instructions into Arm64 instructions with optimisations to improve performance of the emitted Arm64 code."

Prism is continuing to improve. The latest version adds support for processor extensions such as AVX, AVX2, BMI, F16C and FMA, which means that any apps that rely on those extensions will now work under emulation when previously they crashed or refused to run at all. *Starfield*, for example, is built on AVX2.

A growing number of business, creative and development apps are also now natively running on Arm. At launch, only Adobe's Photoshop ran natively, but now that extends to Lightroom, Premiere Pro and Media Encoder, and Adobe has also released beta versions of InDesign and Illustrator. You can see the full list at **tinyurl.com/367qualcomm**. All the major Microsoft titles also run natively, as do Chrome and Firefox, while businesses that rely on CrowdStrike, Ivanti LANDesk or TeamViewer can again rely on Arm-native versions of the software.

This convinced me to switch to a Snapdragon-based laptop for a fortnight. And, rather boringly, almost everything worked fine. I took the laptop on a four-day trip and took full advantage of its all-day battery life, even if I still – due to my own paranoia – carried the charger with me each day. The "almost" is because the beta of Adobe InDesign crashed too frequently for comfort. All of which emphasises how important it is to check that the software you rely on runs well on Qualcomm chips before you switch.

Acer Swift 14 AI (Snapdragon)

A perfectly respectable Copilot+ PC, but it needs more class to stand out at this price

SCORE ★★★★☆

PRICE £1,000 (£1,200 inc VAT) from store.acer.com

ABOVE The Qualcomm version of the Swift 14 AI is a decent laptop, but it's too expensive

You could be forgiven for thinking we have reviewed the Acer Swift 14 AI before, because we have: last month, in fact. But that was its Intel incarnation (*see issue 366, p48*), and this month it's the turn of Qualcomm.

Acer only sells one Qualcomm model, powered by the mid-range Snapdragon X Plus chip. But don't confuse mid-range with slow, as there are ten powerful cores tucked inside; that's why the Swift 14 AI thundered to 13,295 in Geekbench 6's multicore benchmark, over 2,000 more than the Core Ultra 7 258V in the Intel version we tested last month.

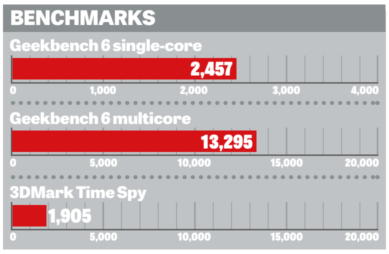
LEFT The Snapdragon X Plus is a powerful chip with impressive battery life

Another benefit of choosing Qualcomm is that it will be almost as fast on battery power as it is on the mains, while Intel's chips slow down. Off grid, the Swift 14 AI scored 2,387 and 13,016 in Geekbench, a drop of less than 3%, while the Intel system fell to 1,996 and 9,127 – 26% and 18% drops respectively. Battery life was another win for the Qualcomm-powered Swift 14 AI, lasting 18hrs 59mins in a light-use test compared to 15hrs 53mins for its Intel equivalent.

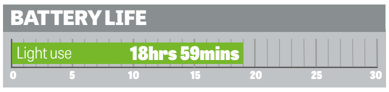
That isn't an apples versus apples comparison, however, as the Intel-badged Acer Swift 14 AI packed an OLED panel – which needs more power – compared to the IPS screen here. There's a gap in quality, too, with this month's unit only covering 75% of the DCI-P3 gamut to 100% of its sibling. It performed well in our colour accuracy tests, though, with an average Delta E of 0.22, but push it close to its 393cd/m² peak if you want to enjoy a crisp white background when working.

Both laptops include a sturdy aluminium chassis that won't weigh you down at 1.3kg, and the keyboard is identical. Sadly, that's not great news for frequent typists, with a shallow and uncushioned feel to the keys. At least they're quiet, while backlighting through and around the keys makes them easy to see in dark conditions.

BENCHMARKS



BATTERY LIFE



The touchpad is large with a particularly generous width, and as with all Acer's Swift AI laptops there's an activity indicator at the top right that lights up when the NPU is called into action. That probably won't happen too often in the next few months, but when Recall finally lands – and other promised enhancements to Microsoft's Copilot+ PCs initiative finally arrive, such as natural language local search – it may even become commonplace. For now, though, it lights up during video calls where the NPU can take advantage of Studio Effects to add blur and artistic effects to calls.

What should be an easily fixable bug (probably the AI trying to be too clever) meant the microphone wasn't working on my unit, but I can confirm that the speakers are fine, so long as you don't push the volume up too high. It struggles to balance more complicated tracks – trebles dominate – but it's passable for music and compelling for films.

As always with Qualcomm laptops, gamers should look elsewhere, but there is acceleration courtesy of the Adreno graphics, as shown by a total of 1,905 in 3DMark Time Spy. I only scraped above 30fps in *Dirt 5* and *Shadow of the Tomb Raider* by dropping to 1080p and the lowest settings, however.

Flip the Swift over and you'll discover that Acer doesn't want you to upgrade this laptop yourself, with ten Torx T5 screws standing in your way. The base came off easily once I fought past them, but this proved a Pyrrhic victory as neither the SSD nor the battery are straightforward to replace. I suspect you'll need to call upon a professional to fix any component.

That means you'll have to rely on external storage if you need more than the supplied 1TB of storage – a quick SSD, returning 6,388MB/sec sustained reads and 5,724MB/sec sustained writes – and that's when the pair of USB-C 4 ports on the left come in handy. You'll also need them for video output as there's no HDMI connector. The two USB-A ports, one on either side, are relatively slow USB 3.2 Gen 1 (5Gbits/sec) offerings.

> **"There's only one model in the range, powered by the mid-range Snapdragon X Plus chip. But don't confuse mid-range with slow"**

Despite the presence of Wi-Fi 7 and Bluetooth 5.4, I struggle to see why the Acer Swift 14 AI Snapdragon is worth £1,200 when you can buy – for example – the Asus Zenbook A14 (*see p58*) for £100 less. It's only when this laptop dips below £1,000, as I suspect is on the cards, that it will become worth consideration. **TIM DANTON**

BELOW The sturdy aluminium chassis is a relatively light 1.3kg

SPECIFICATIONS

10-core Qualcomm Snapdragon X1P-64-100 SoC ● Qualcomm Adreno graphics ● 16GB LPDDR5X RAM ● 14.5in 120Hz non-touch IPS panel, 2,560 x 1,600 resolution ● 1TB M.2 PCIe Gen 4 SSD ● Wi-Fi 7 ● Bluetooth 5.4 ● 1440p IR webcam ● 2 x USB-C 4 ● 2 x USB-A 3.2 Gen 1 ● 3.5mm combo jack ● 65Wh battery ● Windows 11 Home ● 322 x 226 x 14.9mm (WDH) ● 1.3kg ● 1yr RTB warranty ● part code NX.KZXEK.001

Acer Aspire 14 AI

Not the best screen, but if Acer can get the price right on release then it has a Copilot+ PC hit on its hands

SCORE ★★★★☆

PRICE Estimated, from £625 (£750 inc VAT) **from store.acer.com**

I hope you're the patient type, because Acer doesn't expect the Aspire 14 AI to go on sale in the UK until June. Nor has it confirmed a price, so for now I'm using the "from $699" quoted at its CES launch (**tinyurl.com/367aspire**). Normally, these convert dollar for pound, raising the possibility of a laptop with a Core Ultra 5 226V processor and 16GB of RAM for £699. I suspect it will be more, but even at £750, say, that would be a steal.

My test sample included a Core Ultra 7 258V with 32GB of RAM and a 1TB SSD, which is probably the top specification. Despite having a single and sometimes noisy fan, the Aspire 14 AI extracted almost exactly the same scores from the 258V as other laptops, returning 2,728 in Geekbench 6's single-core test and 11,120 in the multicore section. That means superb single-threaded speed, but less so for multithreaded tasks; a limitation made obvious in Cinebench 2024, where the Aspire 14 AI scored 609 compared to 789 for the Qualcomm-powered Swift 14 AI opposite.

Unlike the Swift, however, there's real gaming power here. A 3DMark Time Spy return of 4,410 is as good as you'll get in a non-gaming laptop, and at the panel's native resolution of 1,920 x 1,200 it returned playable averages at Medium settings: 43fps in *Dirt* 5, 41fps in *Shadow of the Tomb Raider* and 50fps in *Cyberpunk 2077*.

The bad news for gamers is that this is a plain 60Hz panel, and displaying colours is not its forte. It covers only 53% of the sRGB gamut, and its colour accuracy stinks with an average Delta E of 4.82. It's one of the clear cutbacks Acer has made to hit such an aggressive price. Still, whites look okay once you push up brightness to the panel's 338cd/m² peak, and it's fine to work on.

Likewise the keyboard. Yes, it lacks the decisive punch of the best, but the keys are easy to hit, the layout sensible and the two-level backlight effective. Acer drops the Swift's indicator on the touchpad to show when the NPU is called into action, but it's a good size and responds well to gestures.

Acer hasn't sacrificed webcam quality in its money-saving pursuits, with the 1080p unit producing crisp results whether or not you switch on AI effects such as blurring. You even have support for Windows Hello logins. I recommend you head into Acer's PurifiedVoice console and check the AI isn't trying to detect multiple voices, though, as that adds unwelcome echo to recordings.

The pair of speakers are respectable considering this laptop's likely price. They're downward-firing, so work best when the laptop is placed on a hard surface, but I found most music to be listenable; it's only when I hit multi-layered tracks such as Björk's "All is full of love" that I reached for the skip button.

Another welcome surprise is that the Aspire 14 AI feels as well made as Acer's more expensive Swift range, with a metal chassis that offers plenty of protection. It's also pretty slim at 16.9mm, making it all the more commendable that Acer includes HDMI 2.1 alongside two Thunderbolt/USB-C 4 ports and a USB-A port on the left. A second USB-A port sits on the right next to a 3.5mm jack, and once you factor in Wi-Fi 6E and Bluetooth 5.4 this is a much better connected laptop than you might expect.

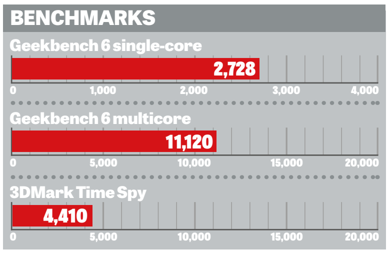
Removing the ten crosshead screws that keep the base in place revealed respectable upgradability. The M.2 SSD – surprisingly quick once again, returning 6,300MB/sec reads and 4,239MB/sec writes – can be whipped out in seconds, while the speakers, battery and M.2 Wi-Fi card are all user-replaceable with due care. This all bodes well as part of Acer's aim to provide more sustainable products, provided it keeps spare parts on sale. Not that you'll need to replace the battery any time soon, as the Aspire 14 AI lasted an excellent 16hrs 36mins under light use.

Acer has one eye on university and secondary school students with this laptop, and if your budget doesn't stretch to trendier brands then it's an excellent choice for that audience. It's built well, the battery will last a full day, and while the screen is an obvious weak point that's likely to be reflected in the price. Or at least, so I hope. **TIM DANTON**

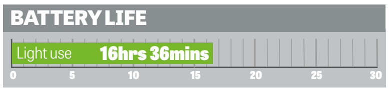
ABOVE The Aspire 14 AI just might be one of the best-value Copilot+ PCs you can buy

> "Acer hasn't sacrificed webcam quality in its money-saving pursuits, with the 1080p unit here producing crisp results"

BELOW The display is a disappointment, but connectivity is excellent for the price



BENCHMARKS



BATTERY LIFE

SPECIFICATIONS (as tested)

8-core (4 P-cores, 4 E-cores) Intel Core Ultra 7 258V processor ● Intel Arc 140V graphics ● 32GB LPDDR5X-8533 RAM ● 14in 60Hz non-touch IPS panel, 1,920 x 1,200 resolution ● 1TB M.2 PCIe Gen4 SSD ● Wi-Fi 6E ● Bluetooth 5.4 ● 1080p IR webcam ● 2 x Thunderbolt/USB-C 4 ● 2 x USB-A 3.2 Gen 1 ● 3.5mm combo jack ● 65Wh battery ● Windows 11 Home ● 319 x 225 x 16.9mm (WDH) ● 1.4kg ● 1yr RTB warranty

Lenovo ThinkPad T14s Gen 6 (AMD)

A great choice for a large-scale rollout of Copilot+ PCs thanks to its speed, build quality and portability

SCORE ★★★★☆

PRICE £1,121 (£1,345 inc VAT) from lenovo.com (including web discount)

ABOVE The ThinkPad T14s is a fine choice for business travellers

This AMD spin on the sixth generation ThinkPad T14s is a laptop for the business masses. There are several signs that it's been built with budget in mind, but none of the sacrifices prevent it from being a classy machine for workers who schlep their laptop from home to office to clients.

As with all ThinkPads, it will make a sober, business-like impression on all those who see it. The trademark black finish and red TrackPoint are in evidence, including a glowing red dot that forms part of the logo on the lid, and its tank-like build quality is only softened by its compact dimensions.

Battery life, however, is not a strength. Two years ago I would have been delighted with 12hrs 30mins in a light-use test, but the Snapdragon variant of the T14s (*see issue 360, p56*) returned 23hrs 29mins. In real life, especially if you push the screen to its full 433cd/m^2 brightness, you'll struggle to squeeze eight working hours out of this AMD variant.

The display is solid but unexciting, using IPS technology and covering 99% of the sRGB gamut. I was pleased to see an average Delta E of 0.34 – indicating excellent accuracy – but a resolution of 1,920 x 1,200 makes working on more than one window tricky, and the screen had to be angled "just so" to produce pleasant whites.

LEFT The superb keyboard has a great layout, as well as a trademark TrackPoint

Yet there are so many positives here that I still enjoyed using the T14s. Top of that list is its keyboard, with deep travel and industry-leading layout. To take one example, the cursor keys are separated out with no function doubling: PgUp and PgDn have dedicated buttons on either side of the top arrow. And while the touchpad is small, its glass coating and the physical buttons above make it simple to navigate Windows 11 or drag and drop folders.

> "There are so many positives here that I enjoyed using the T14s. Top of that list is its keyboard"

Lenovo also spoils us with its spread of ports, with two Thunderbolt/USB-C 4 ports on the left along with HDMI 2.1 and a 3.5mm jack. Two USB-A 3.2 Gen 1 ports (5Gbits/sec) sit on the right, and for £20 you can add a smart card reader. Wi-Fi 7 and Bluetooth 5.4 come as standard, but adding 5G costs £190.

You can upgrade the storage and RAM, too, but the 512GB/32GB combo I tested is the sweet spot for performance and price. The Opal 2 SSD is supremely quick, hitting 7,076MB/sec sequential reads and 4,926MB/sec writes, and few workloads will need 64GB of RAM – particularly considering the £160 extra Lenovo charges.

As is an unfortunate trend, the memory is embedded into the package along with the processor, in this case an AMD Ryzen AI 7 Pro 360. Launched in October 2024, it includes three Zen 5 and five Zen 5c cores. While the 5c is an "efficiency" core, best suited to background tasks, all the cores support multithreading, and that's reflected in a 12,307 return in Geekbench 6's multicore section. Nor is a single-core result of 2,697 to be trifled with.

The 12-core Snapdragon X1E-80-100 version of the T14s I tested scored 14,530 and 2,447 in those respective tests, but it's AMD's more powerful Radeon 880M GPU that could make the most tangible difference in day-to-day use: it returned 3,138 in Time Spy to 1,849 from the Snapdragon, while *Shadow of the Tomb Raider* hit 29fps at Highest settings compared to 19fps.

Both chips include NPUs powerful enough to meet Microsoft's 40 TOPS threshold for Copilot+ PCs and run AI apps locally, but there's no sign of either here – yet. The only time I saw the NPU called into action was in Lenovo's video-enhancing app, Lenovo View, where it did an excellent job of blurring backgrounds (normally blurs struggle with my glasses, but not so here). There's no need to enhance the video itself, as this was top quality.

The AMD version of the T14s is a safer choice for businesses than the Qualcomm version, especially if you take advantage of AMD's Ryzen Pro service for easier remote management. Lenovo also uses recycled materials throughout and provides easy-to-follow guides if you need to replace parts such as the SSD and battery. A three-year warranty, which includes on-site cover, is the cherry on top.

Where Lenovo loses marks is its silly website pricing, with "23% off" at the time of publication; this takes the list price of the spec tested from £1,760 inc VAT to a far more reasonable £1,345.

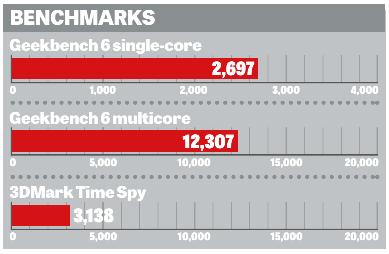
That still isn't cheap, but it's reflected in this laptop's all-round quality and excellent support package. **TIM DANTON**

SPECIFICATIONS

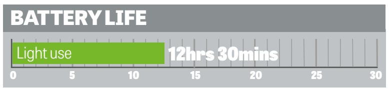
8-core/16-thread AMD Ryzen AI 7 Pro 360 processor ● AMD Radeon 880M graphics ● 32GB LPDDR5x-7500 RAM ● 14in 60Hz IPS non-touch panel, 1,920 x 1,200 resolution ● 512GB M.2 PCIe Gen 4 SSD ● Wi-Fi 7 ● Bluetooth 5.3 ● 1080p IR webcam ● 2 x Thunderbolt 4/USB-C 4 ● 2 x USB-A 3.2 Gen 2 ● HDMI 2.1 ● 3.5mm combo jack ● 58Wh battery ● Windows 11 Pro ● 314 x 219 x 16.9mm (WDH) ● 1.3kg ● 3yr Premier on-site warranty ● part code 21M1001MUK

BELOW Connections are generous, with four USB ports in total

BENCHMARKS



BATTERY LIFE



ABOVE The Fusion 16 is a fine Copilot+ PC for under a grand

PCSpecialist Fusion 16

The first British-assembled Copilot+ PC lacks polish in places but is great value if you're after a 16in system

SCORE ★★★★☆

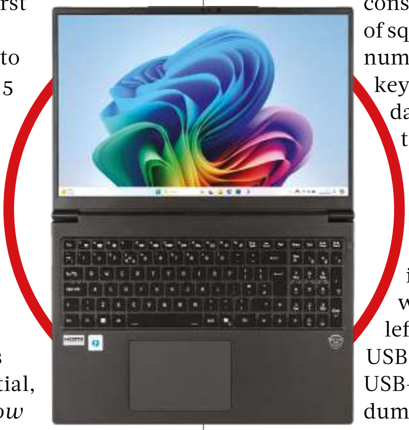
PRICE £833 (£999 inc VAT) from pcspecialist.co.uk/reviews

The quality of Clevo chassis keeps on improving, which is great news for PCSpecialist. It, like every other British PC maker, relies on Chinese and Taiwanese companies for their laptop designs, and this is one of the best. You'll notice the all-metal build the moment you pick it up, along with the MIL-STD 810 sticker to indicate resistance to drops, shakes and extreme heat or cold.

This is also the first British Copilot+ PC we've seen, thanks to the Intel Core Ultra 5 226V's 40 TOPS NPU. It's by no means the quickest chip in Intel's range, but the solid Geekbench scores below reflect how nippy Windows 11 Home feels. There's even gaming potential, with 35fps in *Shadow of the Tomb Raider* at 1080p and 37fps in *Dirt 5* at 1200p (both at Low settings). Upping the resolution to the Fusion's native 2,560 x 1,600 reduced those figures to 23fps and 28fps respectively.

The 16in panel is almost perfectly tuned to the DCI-P3 colour space (it covers 94% out of a 96% volume) while delivering an average Delta E of 0.55. In other words, almost perfect colour accuracy. Gone are the dull panels of previous Clevo chassis, with a peak brightness of 488cd/m^2, and you can manually switch between 60Hz and 144Hz refresh rates. With excellent whites, my only criticism is of its viewing angles.

Work still needs to be done on the speakers. They're okay, with good stereo separation and recognisable bass, but music sounds harsh once you push up the volume. Nor do I love this keyboard. The cursor keys are too easy to hit when you're trying to hit the right Shift key, which is a consequence of squeezing in a number pad. The keys also need more dampening, as do the overly clicky touchpad buttons.



LEFT While the screen is a highlight, the keyboard disappoints

Clevo needs no advice on cramming ports into slim chassis, with four on the left-hand side: two USB-C, HDMI and USB-A. There's also a dummy slot that I tried putting a microSD card into, but the real microSD card slot sits on the right-hand side, along with a second USB-A port and 3.5mm jack.

Opening up the chassis, after removing 11 crosshead screws, reveals another curiosity. Despite a large area, Clevo only includes a 73Wh battery, and that showed itself in a battery life of 15hrs 5mins under light use. That's plenty to survive a full day away from the mains, but it could so easily have been 20 hours with a chunkier battery. The plus side is that the Fusion weighs only 1.3kg, which is unexpected for a 16in laptop.

PCSpecialist has one eye on costs when including the mid-range SolidIGM P41 Plus M.2 SSD, but results of 4,092MB/sec and 2,890MB/sec in CrystalDiskMark's sequential read and write tests remain strong. It's easy to replace if 1TB isn't enough storage, but the 16GB of RAM is integrated onto the CPU package. A package that's kept cool by a small heatsink and single fan, which is one reason why you'll hear more fan noise on this laptop than many rivals. If this irritates you, fire up the unlikely sounding "Fn keys and OSD" in the list of apps and Clevo's Control Center software appears, allowing you to select a Quiet fan profile, or Performance if you want to extract the most out of the Core Ultra chip.

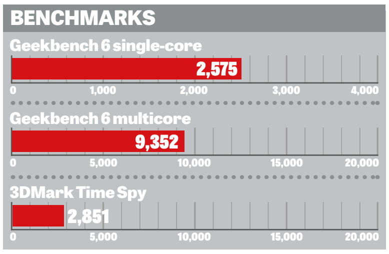
You can also deactivate the 1080p webcam from here. Thanks to the NPU it applies background blur well, but it falls behind the webcams in the latest big-brand laptops when it comes to colour capture. I looked as if I was suffering from a bout of the flu.

Where PCSpecialist comes up trumps is its three-year warranty, even if only the first year covers parts, and you'll have to pay courier costs to Wakefield after six months.

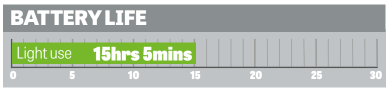
> "The 16in panel is almost perfectly tuned to the DCI-P3 colour space while delivering an average Delta E of 0.55"

With an aggressive price, local AI support and the impressive 16in display, the Fusion 16 easily earns four stars despite my list of niggles. If you're on a tight budget, and want a Copilot+ PC with strong UK support, it's a great choice. **TIM DANTON**

BENCHMARKS

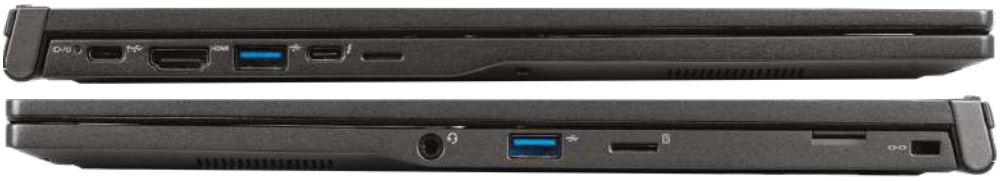


BATTERY LIFE



SPECIFICATIONS

8-core (4 P-cores, 4 E-cores) Intel Core Ultra 5 226V processor ● Intel Arc 130V graphics ● 16GB LPDDR5X-8533 RAM ● 14in 60Hz OLED non-touch panel, 2,560 x 1,600 resolution ● 1TB M.2 PCIe Gen4 SSD ● Wi-Fi 6E ● Bluetooth 5.3 ● 1080p IR webcam ● 1 x Thunderbolt 4/USB-C 4 ● 1 x USB-C 3.2 Gen 2 ● 2 x USB-A 3.2 Gen 2 ● HDMI 2.1 ● 3.5mm combo jack ● 73Wh battery ● Windows 11 Home ● 383 x 253 x 20mm (WDH) ● 1.3kg ● 3yr RTB warranty (first six months C&R, first year parts)



BELOW You're spoilt for choice when it comes to ports

Bag a software bargain

Don't pay full price for software when we can offer you huge reductions on genuine products

NORTON 360 PREMIUM for £19.99

SAVE 89%
2 YEAR PRE-PAID SUBSCRIPTION
norton
10 DEVICES
Norton 360 Premium
Continuous protection renews automatically each year

10 DEVICES **2YR LICENCE** **75GB CLOUD STORAGE**

tinyurl.com/norton360premium

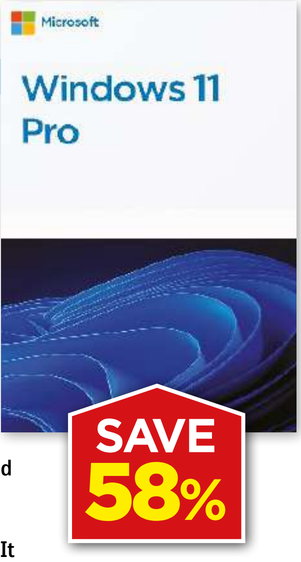
We've negotiated a killer deal with Norton. No subscriptions, just a one-off bargain price of £19.99 compared to the regular £179.99 charge. That buys you two years of cover from the powerful Norton Security suite across ten devices.

And because it's the Premium version, you get a host of extra tools. There's 75GB of cloud storage for secure backups, plus the full version of Norton Secure VPN, both to protect your identity and provide a way of watching British TV while abroad.

Norton Parental Control provides tools to see exactly what your kids are up to on their various devices, and you also get GPS location monitoring for Android and iOS.

To round things off, Norton Password Manager generates and stores passwords across all your devices, while SafeCam for PC stops cybercriminals attempting to take photos with your webcam without your knowledge.

WINDOWS 11 PRO UPGRADE for £49.99



1 PC **PERPETUAL LICENCE**

tinyurl.com/win11pro-upgrade

Want to upgrade from Windows 11 Home to Windows 11 Pro? Or perhaps you're looking to move up from Windows 10 Home?

Whatever your motives, a Windows 11 Pro upgrade licence is a great choice. The first reason is simple: price. Microsoft charges £119.99 for a retail licence of Windows 11 Home, a staggering £219.99 for Windows 11 Pro, and £119.99 for its own upgrade licence from 11 Home to Pro. By choosing this licence – and avoiding the many dubious sources of licences you may find online – you cut that price substantially.

Unlike Windows 11 Home, Windows 11 Pro enables you to connect to a business domain. It also provides BitLocker to encrypt whole drives. Best of all, you can create and host virtual machines using Hyper-V, which is ideal for testing new software or, if you're a developer, seeing how your software performs on a fresh OS.

Note that the upgrade only works from an activated copy of Windows 11 Home, so if you're currently using a Windows 10 Home system then you'll need to upgrade from that to Windows 11 Home before this upgrade can work.

Want to upgrade from Windows 7 or 8? Or building a PC from scratch? Then head to **tinyurl.com/windowspro11** and grab a full 1-PC licence for Windows 11 Pro for only £79.99.

ACRONIS TRUE IMAGE 2025 ADVANCED for £29.99

Acronis True Image
#1 Cyber Protection
Fast backup • Disk cloning • Easy setup
SAVE 40%

1 PC OR MAC **1YR LICENCE**

tinyurl.com/trueimage2025

Acronis provides a one-stop security shop here, combining a full backup suite with comprehensive anti-malware protection.

It offers the full gamut of backup options, from individual files to complete drive imaging (with smart incremental and differential options to encourage daily backups without filling your storage), active disk cloning for migrating to faster or bigger hard drives, and support for cloud-hosted backups to give you access to your files from anywhere on any device.

There's also an Archive option for offloading larger files to the cloud, a Sync tool that works with two PCs with Acronis installed, and a host of additional disk-related tools, including system clean-up and drive-scrubbing tools, Acronis Secure Zone (an encrypted partition for storing sensitive files) and Acronis Universal Restore (a tool for migrating all your apps, documents and settings to a new PC).

Acronis True Image is simple to use, with a user-friendly front end that's packed with lots of wizards and step-by-step guides. And there's plenty of advanced tuning available to those who want full control over their system.

The Advanced package improves on Essentials by offering you 50GB of cloud storage. You can still back up to local disks, network attached storage or remote destinations via FTP. You can also back up Microsoft 365 data and set up automatic replication.

Netgear Nighthawk RS200

It doesn't fully deliver the Wi-Fi 7 dream, but this mid-price router is surprisingly fast and capable

SCORE ★★★★☆

PRICE £167 (£200 inc VAT) from amazon.co.uk

When I first heard about the Nighthawk RS200 router, I was genuinely excited. Wi-Fi 7 has so far tended to be an expensive luxury: Netgear's flagship Nighthawk RS700S router cost a whopping £800 when introduced (*see issue 353, p76*), and even the cut-down Nighthawk RS300 still came in at a fairly hefty £300 (*see issue 361, p72*). But with the RS200 shaving another £100 off that, Wi-Fi 7 is finally getting down to sensible prices.

Unfortunately, my excitement was quickly overtaken by concerns about how the cost saving has been achieved. If there's one big innovation that defines Wi-Fi 7, it's MLO – the multi-link operation mode that can increase bandwidth and improve reliability by letting devices connect across the 2.4GHz, 5GHz and 6GHz radio bands simultaneously. However, that's off the table for the RS200 as it has no 6GHz radio; it's strictly a dual-band design, in the same mould as older Wi-Fi 5 and Wi-Fi 6 models.

The RS200 also misses out on another key feature of Wi-Fi 7, namely its doubling of the channel width to 320MHz. The 5GHz radio used here is limited to the same 160MHz maximum as previous generations, meaning it simply can't broadcast as much data at once.

By now you might be wondering whether the Nighthawk RS200 actually has any advantage over a cheap Wi-Fi 6 model, but the newer standard does at least allow for a maximum connection speed of 5.8Gbits/sec on the 5GHz band – a decent step up from the 4.8Gbits/sec supported by Wi-Fi 6.

The RS200 has a few other technical plus points, too. Despite being the cheapest router in Netgear's current lineup, it sports a pair of 2.5GbE sockets at the rear, so you can connect both multi-gigabit broadband and a high-bandwidth local device such as a NAS appliance. If you don't have a NAS, you can alternatively use the 5Gbits/sec USB port to share files from an external SSD or flash drive, although of course you won't get the data security or app support of a dedicated appliance.

Netgear hasn't skimped on software features, either, which is to say the RS200 uses basically the same firmware as every other Netgear router I've tested for the past eight years. Management is split awkwardly across two different interfaces – a traditional, rather clunky web interface and a much slicker mobile app. You'll need to use the former to access technical settings such as IP address management, port forwarding and wireless configuration; the app is more limited, but it's brilliant for initial setup. You can simply use your phone to scan the QR code sticker on the top of the router to get connected, then tap through the process to set your network name, password and so on.

The mobile app also provides access to Netgear's parental control and network security services, although these are provided only as 30-day trials, after which you'll have to pay £50 and £85 a year respectively to keep them going. Again, this is business as usual for Netgear, but if you're on a tight budget then these extra costs could well count against the RS200, considering that TP-Link offers similar services for a lower price and Asus builds them all in for free.

To test the Nighthawk RS200's real-world Wi-Fi performance, I tried downloading files over a Wi-Fi 7 connection from various rooms around my home, and was very pleasantly surprised by the speeds I saw. While there's no 6GHz support, Netgear somewhat makes up for that by using the same 5GHz radio unit as found in the top-end RS700S, which is twice as fast as the one in the RS300. Even without the 320MHz channel width, performance compares very well to other routers I've seen at this price, and indeed to some costing rather more.

Since I've recently moved to a new property, the speeds shown in the graph below aren't directly comparable to the figures quoted in previous reviews, but I really can't complain about a maximum transfer rate of 136MB/sec at short range and a worst-case minimum of 28MB/sec at the far end of my new home. That's enough bandwidth to carry ten Zoom calls at once, and Netgear claims the router can support up to 80 connected clients in total over an area of up to 186m².

If you're specifically excited about the potential of Wi-Fi 7 then you still might choose to give the RS200 a miss. Its performance is competitive right now, but 6GHz and MLO connections are only going to become more commonplace with coming generations of laptops and phones. In a year or two you may feel that this router is holding you back.

In truth, though, the Netgear Nighthawk RS200 isn't aimed at enthusiasts eager to try out the latest technologies. Instead, this device is tailor-made for the typical home, or even a small office, where it provides a solid, reasonably priced and forward-compatible Wi-Fi solution without a painful premium. **DARIEN GRAHAM-SMITH**

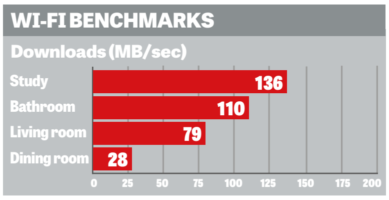
LEFT Although it lacks MLO, the RS200 is a capable Wi-Fi 7 router

> "Performance compares very well to other routers we've seen at this price, and indeed to some costing rather more"

LEFT The Nighthawk RS200 is tailor-made for the typical home

RIGHT Two 2.5GbE sockets allow you to connect multi-gigabit broadband and a NAS

WI-FI BENCHMARKS



SPECIFICATIONS

Dual-band 2.4GHz/5GHz Wi-Fi 7 router ● 4 streams ● 2.5GbE WAN, 2.5GbE LAN, 3 x GbE LAN ● 2GHz quad-core processor ● 150 x 102 x 249mm (WDH) ● 2yr limited warranty

Your bonus software

Total value this month £176

We scour the globe to negotiate the best software deals for our readers, from extended licences to full programs you don't need to pay a penny for. Here's this month's lineup

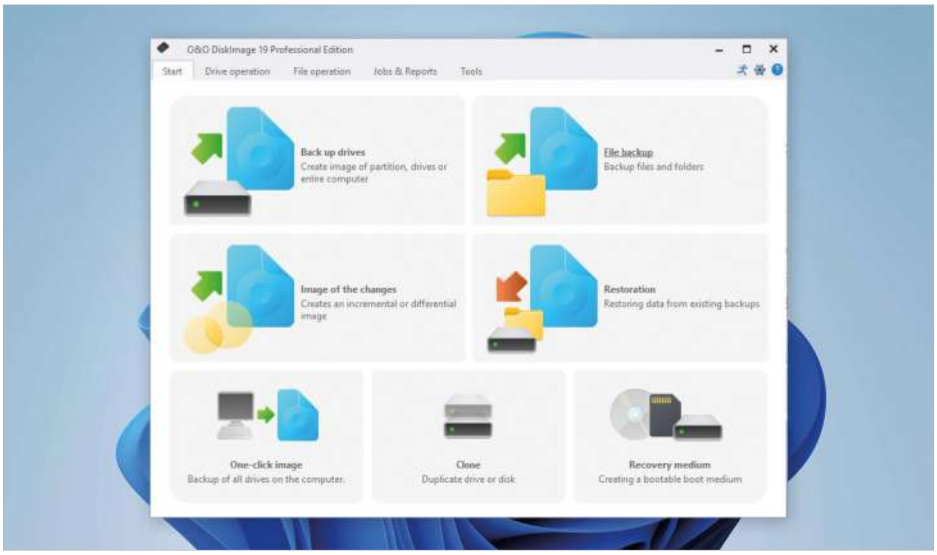
DiskImage 19 Professional

- **Full product worth £36**
- **oo-software.com**

REQUIRES Windows 10 or later; 250MB hard drive space; online registration

If you've ever been through the shock of data loss, or spent half a working week rebuilding a broken system, you'll know the importance of creating and maintaining regular, full backups of your computer and its drives. Having a fallback copy of both Windows – including all your favourite apps and painstakingly crafted settings – and your irreplaceable documents, media and other files is a no-brainer. The only question is: what's the best way to go about managing it?

As part of this month's software download bundle, we're offering O&O DiskImage 19 Professional, which could well be the answer. It provides all the tools you need for backing up individual documents – such as selected files and folders – and for creating comprehensive images of entire partitions and drives. With a wide range of configurable options it's not necessarily a tool for complete beginners, but it does provide hints and tips to help you protect your data, and this latest version makes things easier than ever with a revamped interface.

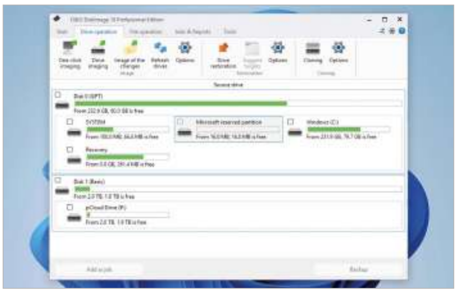

O&O DiskImage 19 Professional Edition
Start
Drive operation
File operation
Jobs & Reports
Tools
Back up drives
Create image of partition, drives or entire computer
File backup
Backup files and folders
Image of the changes
Creates an incremental or differential image
Restoration
Restoring data from existing backups
One-click image
Backup of all drives on the computer.
Clone
Duplicate drive or disk
Recovery medium
Creating a bootable boot medium

Once you've installed the software, your first step will be to choose a function by clicking on the appropriate tile. Options include drive imaging, starting a file backup process, creating a one-click image and creating a bootable disk.

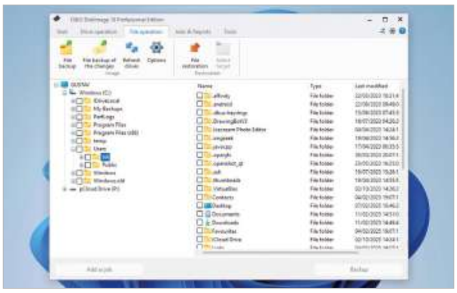
When using any software of this kind, the imaging option often provides the simplest and most comprehensive way to achieve what you need, including both the operating system and files in a convenient single archive. In this case, you can create images of all your drives with just a click or two – but if that's not for you, select a source drive or volume, and click "Start drive imaging" to run a backup just as easily using the default settings.

DiskImage isn't just a tool for imaging complete drives; you can also use it to back up individual files and folders. Doing so is a simple case of browsing in a familiar File Explorer-type window for the items you want to back up, ticking folders and files as you go. There are similar options to run complete, incremental or differential backups, to compress or encrypt your archives, and more.

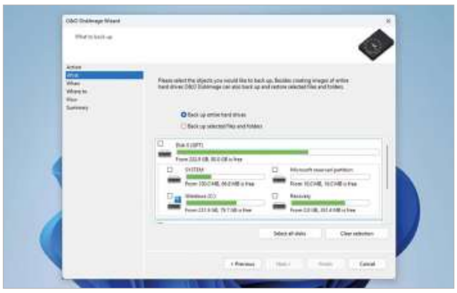
And when it comes to managing and restoring backups, DiskImage again has all the tools you need. You can restore entire images or select individual files and folders, and even mount your image files in Windows and browse them the way you would a regular attached drive.



ABOVE Browse the layout of all drives and partitions attached to your system, then select which ones you want to back up



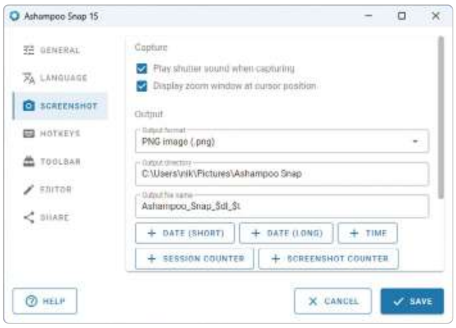
ABOVE If you don't want to back up a complete drive, but just a selection of files and folders, switch to the File Operations tab



ABOVE The wizard interface lets you create a complete backup of every volume attached to your computer with only a few clicks

Ashampoo Snap 15

- A flexible way to take screenshots, including support for multi-monitor setups
- Use the delay feature to capture timed shots within games, or grab multiple frames to make a video
- Perform scrolling captures to grab lengthy documents, or to copy entire web pages into a single image file


Ashampoo Snap 15
GENERAL
LANGUAGE
SCREENSHOT
HOTKEYS
TOOLBAR
EDITOR
SHARE
+ DATE (SHORT)
+ DATE (LONG)
+ TIME
+ SESSION COUNTER
+ SCREENSHOT COUNTER
HELP
CANCEL
SAVE

Capture

☑ Play shutter sound when capturing

☑ Display zoom window at cursor position

Output

Output format: PNG image (.png)

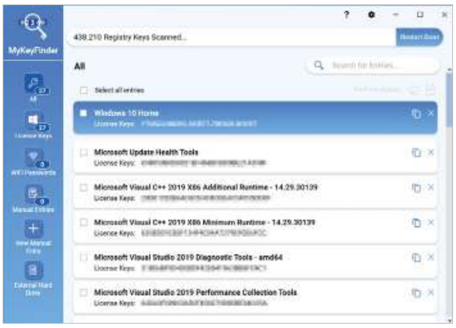
Output directory: C:\Users\nik\Pictures\Ashampoo Snap

Output file name: Ashampoo_Snap_$dl_$t

Full product worth £35 **ashampoo.com**
REQUIRES Windows 7 or later; 70MB drive space; in-application registration

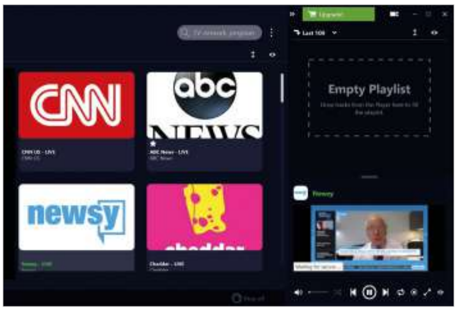
Abelssoft MyKeyFinder 2023

- Speed the process of reinstalling Windows and applications by keeping all your registration keys in one place
- Generate a report containing all keys, including those for Windows, Office, Adobe and more
- Print your list of licences, save it as a PDF, or paste it into your preferred note-taking app


MyKeyFinder
438.210 Registry Keys Scanned...
All
Select all entries
Windows 10 Home
Microsoft Update Health Tools
Microsoft Visual C++ 2019 X86 Additional Runtime - 14.29.30139
Microsoft Visual C++ 2019 X86 Minimum Runtime - 14.29.30139
Microsoft Visual Studio 2019 Diagnostic Tools - amd64
Microsoft Visual Studio 2019 Performance Collection Tools
License Keys

Full product worth £20 **abelssoft.com**
REQUIRES Windows 10 or later; 30MB drive space; in-application registration

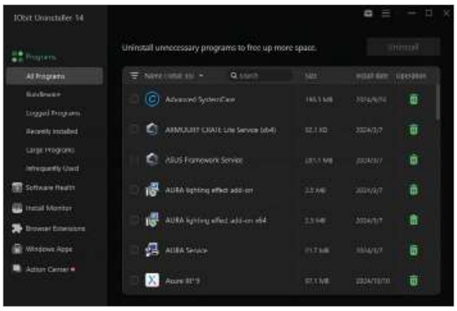
Audials TV Recorder 2025


CNN
abc NEWS
newsy
cheddar
Empty Playlist

Full product worth £10 **audials.com**
REQUIRES Windows 10 or later; 200MB drive space; in-application registration

- Record streaming TV shows to your computer, to watch later at your leisure
- Easily find shows with keyword-based search
- Also works with podcasts and YouTube videos to serve as a complete media management tool

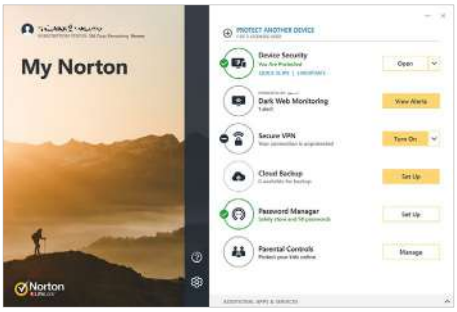
Iobit Uninstaller 14


IObit Uninstaller 14
Uninstall unnecessary programs to free up more space.
Programs
All Programs
Advanced SystemCare
ASUS Framework Service
AURA lighting effect add-on
AURA Service

Six months of updates worth £10 **ascomp.de**
REQUIRES Windows 7 or later; 100MB drive space; online registration

- Remove applications from your PC without leaving junk files and Registry clutter behind
- Clear out remnants missed by other uninstallers
- Force Uninstall option for programs whose uninstaller no longer works

Norton 360 Standard 2025


My Norton
Norton
Device Security
Dark Web Monitoring
Secure VPN
Cloud Backup
Password Manager
Parental Controls
Open
View Alerts
Turn On
Set Up
Manage

One-device, one-year licence worth £65 **uk.norton.com** **REQUIRES Windows 8 or later; 300MB drive space; online registration**

- Protect your PC against malware and other threats with this comprehensive security suite
- Integrated firewall and web safety feature
- Secure VPN to encrypt your web traffic, plus Dark Web Monitoring with Norton LifeLock

How to claim your bonus software

1 Visit **pcprodownload.co.uk.** First, enter the issue number (367 this month). Next, enter your email address and the coupon code printed on the cover's spine (or directly on the front cover of digital issues of the magazine). We'll then send an email to confirm that your code has been registered. Follow the instructions in the email to access the download area.

2 Once you're in the download area, you can access this month's bonus software by navigating to the relevant product page and clicking the red Install button. For trial software, freeware and other downloads, click the Install button below the product description, or follow the onscreen instructions (please make sure to read these carefully).

3 If the software needs registering, click the purple Register button, or follow the instructions on the left of the product page (again, please read these carefully). In some cases, you may need to register for a *PC Pro* software store account – if you don't already have one – and you might be prompted to reenter the coupon code on the spine or cover.

4 Please be sure to install and register your bonus software before the date that's specified below. After this date, we can't guarantee that it will still be possible to download or register this issue's bonus software.

Remember to claim your software by 30 April 2025*

pcprodownload.co.uk

Any problems?

If you need assistance with the coupon code or have registration issues, please contact us at **software@pcpro.co.uk**

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*Codes are sometimes limited, so please claim early to avoid disappointment

Oppo Pad 3 Pro

A premium Android tablet that takes the fight to Apple's iPad, but it's not worth the list price

SCORE ★★★★☆

PRICE Tablet only, £416 (£499 inc VAT) from oppostore.co.uk

ABOVE The Pad 3 Pro is a well-built Android tablet, but don't pay the full price for it

The Oppo Pad 3 Pro joins the growing ranks of premium Android tablets, with its obvious competitor being the £449 OnePlus Pad 2 (*see issue 364, p86*). The two are essentially identical other than their colour – here, your eyes are treated to Starlit Blue rather than the Pad 2's grey.

At £499 with 256GB of storage, it's also a rival to the 256GB iPad, which costs £479 – although, unlike Apple, Oppo doesn't offer any other storage or cellular options. You'll soon be able to partner the tablet with the Oppo Pencil 2 Pro stylus and a full Qwerty keyboard with kickstand, but neither is currently available to order.

The slim, unibody design is well constructed and looks smart, with curved sides that sit naturally in the hand. The rough edges around the speaker cutouts detract from the luxury feel, and it's heavier than the iPad at 586g versus 477g, but it's light enough to carry around comfortably.

An 8MP camera sits along the upper edge of the tablet when held in landscape mode. This makes sense for Zoom and Teams calls, and the same camera also handles face unlock, with great responsiveness even in low light. The 13MP camera at the rear is fine for the odd snap, but don't buy this tablet expecting to take stunning images.

ABOVE The 13MP camera at the rear is fine for the odd snap

One of the Oppo Pad 3 Pro's best features is its display. It's a spacious 12.1in offering – distinctly larger than the 10.9in iPad – with a sharp 3,000 x 2,120 resolution, an adaptable refresh rate that goes up to 144Hz and a peak brightness of 600cd/m² when viewing SDR content. It also has Dolby Vision HDR support, pushing up to 900cd/m². The viewing experience is brilliant whether you're watching a movie, streaming a TV show or playing a game; my only caveat is that it's hard to read in direct sunlight.

Oppo helps you stay productive with a neat multitasking mode that shows three apps on screen at once. If you're using the optional keyboard case, you can use shortcut keys to quickly browse the tablet, and open and close apps without having to use the touchscreen.

The software suite includes the now customary set of AI tools, though these didn't blow me away. The tablet can read web pages aloud, but it wasn't always smart enough to detect where the actual article started, reading out page furniture instead. The AI Summary feature, which scans an article and generates a summary, works better, but is hardly groundbreaking.

Although the Snapdragon 8 Gen 3 is now a year old, it's one of the most powerful chips you'll find in an Android tablet and is partnered with a generous 12GB of RAM. The Oppo Pad 3 Pro had no problem handling video streaming, intensive gaming, lengthy social media sessions and video calls. Even when multitasking with three apps side-by-side, everything ran smoothly with no signs of slowdown.

It's good for gaming, too: Oppo's Hyperboost overlay lets you directly inspect the current frame rate, the load on the chipset and even the temperature of the tablet. You can switch to "Pro" mode for maximum performance during games, or toggle to "Low power" to preserve battery life.

On that note, I was impressed that the Pad 3 Pro's battery life dropped by only 7% in an hour of streaming Netflix over Wi-Fi. When using the tablet intensively to browse, watch video and work, I enjoyed a full two days' usage out of a charge. And when not in use the Pad 3 Pro barely consumes any power at all, with Oppo claiming it can last up to 40 days on standby. When you do need to top up, Oppo's 67W charger will refill the battery swiftly, but this isn't included in the box. I plugged in my own 60W charger and saw the battery increase by 10% in 15 minutes.

The iPad may rule the roost when it comes to the range of accessories and apps available, but if you're looking for an Android-based alternative the Oppo Pad 3 Pro is a solid choice. However, its list price of £499 is too steep when OnePlus is selling the same hardware for £50 less, so only consider it during promotions.

JOHN McCANN

> **"One of the Oppo Pad 3 Pro's best features is its display. It's a spacious 12.1in offering with a sharp 3,000 x 2,120 resolution"**

LEFT An optional Qwerty keyboard will be available to partner the Pad 3 Pro soon

SPECIFICATIONS

8-core Qualcomm Snapdragon 8 Gen 3 SoC ● Adreno 750 graphics ● 12GB RAM ● 12.1in 144Hz IPS touchscreen, 3,000 x 2,120 resolution ● 256GB storage ● 13MP rear camera ● 8MP front camera ● Wi-Fi 7 ● Bluetooth 5.4 ● USB-C 3.2 Gen 2 ● 9,510mAh battery ● Android 14 with ColorOS 14.1 (three OS updates) ● 269 x 6.5 x 195mm (WDH) ● 586g ● 2yr warranty

palicomp

01270 898 104
sales@palicomp.co.uk

pro-series

mid [PRO1]

£449.99

CPU	AMD RYZEN 5 8500G
Core	6 Cores - 12 Threads
Clock	(3.5/5Ghz Turbo)
Mob	ASUS TUF A620M-PLUS WIFI
RAM	ADATA 16GB DDR5 5600Mhz
M.2	TRANSCEND 1TB M.2 nVME
GPU	AMD RADEON Graphics
Case	KOLINK Observatory HF MESH
O/S	*NO OPERATING SYSTEM*
PSU	BUILDER 500W PSU

Max [PRO2]

£979.99

CPU	AMD RYZEN 5 7600X
Core	6 Cores - 12 Threads
Clock	(4.7/5.3Ghz Turbo)
Mob	ASUS PRIME B650M-A WIFI II
RAM	ADATA 32GB DDR5 5600Mhz
M.2	TRANSCEND 1TB M.2 nVME
GPU	NVIDIA RTX4060 TI 16GB
Case	1stPlayer D3-A aRGB - Black
O/S	*NO OPERATING SYSTEM*
PSU	CIT 700W PSU

UBER [PRO3]

£1159.99

CPU	INTEL Core i5 14600K
Core	14 Cores - 20 Threads
Clock	(2.6/5.3Ghz Turbo)
Mob	ASUS B760M-K
RAM	ADATA 32GB DDR5 5600Mhz
M.2	ADATA 2TB S70 Blade M.2 nVME
GPU	NVIDIA RTX4060 TI 16GB
Case	GAMEMAX F15M MESH
O/S	*NO OPERATING SYSTEM*
PSU	BEQUIET 850W Gold PSU

Aurora RANGE

i3 Aurora [AUR1]

£629.99

CPU	INTEL Core i3 14100F
Core	4 Cores - 8 Threads
Clock	(3.5/4.7GHz)
Mob	ASUS B760M-K
RAM	ADATA 16GB DDR5 5600Mhz
M.2	TRANSCEND 1TB M.2 nVME
GPU	NVIDIA RTX3050 8GB
Case	GAMEMAX Abyss Mini RGB
O/S	MICROSOFT Windows 10/11
PSU	CIT 600W Bronze PSU

i5 Aurora [AUR2]

£999.99

CPU	INTEL i5 14400F
Core	10 Cores - 16 Threads
Clock	(Turbo 4.7Ghz)
Mob	ASUS B760M-K
RAM	CORSAIR 32GB DDR5 6000Mhz
M.2	ADATA 2TB M.2 NVMe
GPU	NVIDIA RTX4060 8GB
Case	CORSAIR iCUE 4000X
O/S	MICROSOFT Windows 10/11
PSU	CORSAIR 650W PSU

i7 Aurora [AUR3]

£1599.99

CPU	INTEL Core i7 14700KF
Core	20 Cores - 28 Threads
Clock	(3.4/5.6Ghz Turbo)
Mob	ASUS PRIME Z790-P WIFI - DDR5
RAM	CORSAIR 32GB DDR5 6000Mhz
M.2	ADATA 1TB S70 Blade M.2 nVME
GPU	NVIDIA RTX4070 12GB
Case	CORSAIR iCUE 4000X RGB
O/S	MICROSOFT Windows 10/11
PSU	CORSAIR 650W Gold PSU

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Samsung Galaxy S25 Ultra

Samsung's slick AI integration coupled with unbeatable hardware make this the best high-end phone around

PC PRO ★★★★★ A-LIST

SCORE ★★★★★

PRICE 256GB, £1,041 (£1,249 inc VAT) from samsung.com/uk

Samsung's newest top-grade smartphone has been accused of copying Apple, but it outshines the latest iPhone with a brighter display, smarter AI features and a lighter frame. It's the best Android phone I've tested, and the best phone you can buy right now.

It's not cheap. Pricing starts at £1,249 for 256GB of storage, with upgrades to 512GB for £1,349 or 1TB for £1,549. Colour options are Titanium Black, Grey, Silverblue and Whitesilver; the Samsung website also offers online-exclusive Jadegreen and Pinkgold finishes, as well as a sombre Jetblack. There's an online trade-in deal, too.

Measuring 163mm tall and 78mm wide, it's almost identically sized to the iPhone 16 Pro Max (*see issue 363, p72*). The titanium frame is sturdy, and the floating camera arrangement on the back suits me better than the iPhone 16 Pro Max's unsightly block.

There are a couple of downgrades from the S24 Ultra (*see issue 354, p58*). The Bluetooth radio for the S Pen stylus is gone, so you can no longer use it for air gestures such as taking photos remotely; the new phone also has no internal magnets for Qi2 charging, so if you want to attach snap-on accessories you'll need a suitable case.

Perfect display

The Galaxy S25 Ultra's display is the closest to perfection I've tested. The S24 Ultra's screen was already great, but the new model gains an extra 0.1in in diagonal size, thanks to slimmer bezels, and is brighter than the S24 Ultra when viewed outdoors.

In our testing, we measured a maximum brightness of 1,860cd/m^2, beating the iPhone 16 Pro Max (1,553cd/m^2) by a fair margin, though falling short of the insane 2,469cd/m^2 achieved by the Google Pixel 9 Pro XL. The Galaxy S25 Ultra beat the iPhone for colour reproduction too, with wider coverage of the DCI-P3 colour space (91% versus 81%) and an impressively low Delta E of 0.24.

As well as looking fantastic, the S25 Ultra's screen should be durable, thanks to the latest Corning Gorilla Armor 2 for resistance to drops and scratches.

Let's talk AI

A new Galaxy phone inevitably brings new AI capabilities, and my favourite addition here is cross-app actions. For example, I tried pressing the side button on the S25 Ultra and saying: "Look up the date and time of the Oscars, add it to my calendar and then text it to Mike." To my delight, the phone located the info online, connected to Google Workplace to add it to my calendar, then texted the details to my brother. Currently the agentic AI works with Samsung's and Google's apps and a handful of third-party services such as WhatsApp and Spotify; I look forward to seeing the list expand.

ABOVE The Galaxy S25 Ultra is the best phone you can buy

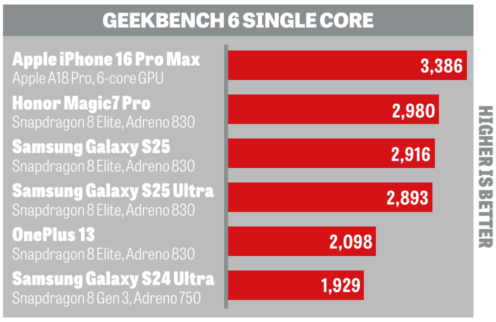
> "The Galaxy S25 Ultra's display is the closest to perfection I've tested and is even brighter than the Galaxy S24 Ultra"

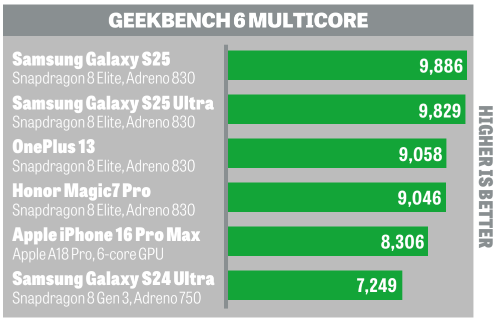
LEFT The titanium frame gives the phone a suitable sturdy feel

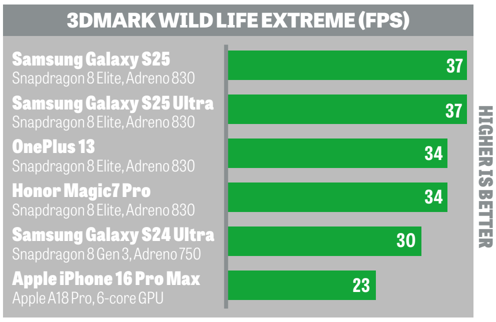
Then there's AI Select, which looks at the content on your screen and provides contextually relevant action. I was able to turn a portion of a YouTube video into a shareable GIF with a couple of taps. Circle to Search can now recognise emails, phone numbers and URLs on your screen – even sounds and background music – and with the help of Google Gemini you can ask questions about a video you're watching or a photo on your screen.

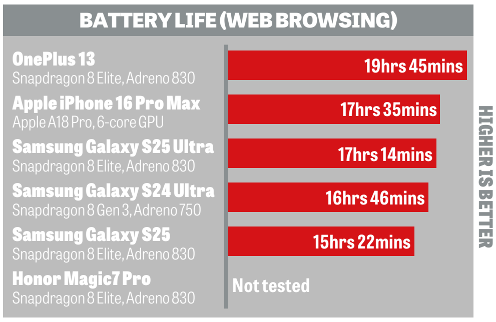
Other features focus on personal assistant functions. Now Brief gives you a summary to start your day, including weather, appointments, news headlines and suggested Spotify playlists. Some of the news stories it came up with weren't of interest, but it's supposed to learn about your interests over time, so it could quickly become a valuable feature. There's also the Now Bar, which puts smart info on your lock screen, from sports scores to reminders and directions.

One final addition I appreciate is call transcription. It's a simple idea, but it's great to be able to review the contents of a call after you hang up, and for longer conversations you can ask for an AI summary. Naturally, both parties on the call must give their consent.









Ultrawide boost

Compared to the S24 Ultra, the only upgrade to the S25 Ultra's camera hardware is the ultrawide sensor, which jumps from 12MP to 50MP. Otherwise, you benefit from the same 200MP main sensor, telephoto and selfie cameras as on the previous Ultra. However, the app controls have been simplified, so it's easier to find the various buttons while freeing up more room for your live view.

The main camera produces terrific photos, with vibrant colour and more fine detail and solidity than similar shots taken on the iPhone 16 Pro Max, although the iPhone's images tend to be brighter overall. Test shots with the new ultrawide camera were equally packed with detail, while low-light performance is remarkable, producing clean images in almost complete darkness. I preferred the S25 Ultra's portraits to the iPhone's – it gave my face a warmer tone, with my blue shirt popping more against an artfully blurred background.

LEFT Samsung's AI features, such as "sketch to image", are genuinely useful

There were only a few tests where I felt the Samsung slipped behind. One was when I tried taking a 10x zoom shot of a clock; here the iPhone's brighter sun and lighter blue sky made for a more eye-catching image, although the S25 Ultra still captured greater detail. The iPhone also produced sharper results in macro mode. Overall, though, the Galaxy S25 Ultra makes a worthy competitor to Apple's best camera phone.

New AI photo-editing tricks include an improved edit feature that does a better job than ever of removing unwanted subjects from your images. There's also a fun "sketch to image" tool; I used the S Pen to draw a crude doodle of a bee on top of a flower, and the phone turned it into a photorealistic rendering in seconds.

Video-recording capabilities meanwhile are close to professional quality, with 10-bit HDR support and the option to shoot in Samsung Log format for more colour control in post-production. The new Audio Eraser feature emulates the iPhone's ability to remove unwanted background noise from your footage, and goes further by letting you tune certain sound types, such as wind, voices, music and crowds.

The fast show

With an overclocked Snapdragon 8 Elite chip and 12GB of RAM, the S25 Ultra is one of the fastest phones around. I tried flipping back and forth between over a dozen open apps, including Chrome, Spotify and Photos, and the experience remained smooth. And for gaming, it's an absolute beast – I enjoyed rock-solid frame rates in *Diablo Immortal*, even with over a dozen enemies on screen.

That's reflected in Geekbench, where the S25 Ultra beat the mighty iPhone 16 Pro Max in the multicore section, though it trailed in the single-core test.

BELOW The cameras are largely the same high-quality models as on the S24 Ultra

While the S25 Ultra isn't the longest-lasting phone we've tested, it's up there. With the screen set to the default 120Hz refresh rate, I timed 17hrs 14mins of continuous web surfing over 5G – about 20 minutes less than the iPhone 16 Pro Max, but 30 minutes more than last year's S24 Ultra. Switching to the more power-efficient 60Hz screen mode gained an extra 81 minutes.

The phone can also recharge quickly, at up to 45W; after 30 minutes of charging, my fully drained S25 Ultra got back up to 71%, while the iPhone 16 Pro Max – which is limited to 30W charging – only reached 55%.

> "The main camera produces terrific photos, with vibrant colour and more fine detail than similar shots taken on the iPhone 16 Pro Max"

The phone to beat

The Galaxy S25 Ultra looks and feels familiar in many ways, but it also brings significant innovations. In particular, the ability to instruct AI to perform complex processes across multiple apps could change the way we interact with our phones forever.

The best may be yet to come, as Samsung promises seven years of feature and security updates. That's the longest support period you'll find anywhere, matching Google's commitment for its Pixel phones. With that sort of longevity, plus its existing AI smarts, superb display, top-notch cameras, super-smooth performance and long battery life, the Galaxy S25 Ultra is a tremendously impressive proposition – so much so that I'm tempted to switch to Android myself. **MARK SPOONAUER**

SPECIFICATIONS

8-core Qualcomm Snapdragon 8 Elite SoC • 12GB RAM • Adreno 830 graphics • 6.9in 120Hz AMOLED screen, 1,440 x 3,120 resolution • 5G • 256GB/512GB/1TB storage • dual nano-SIM • IP68 • quad 200MP/10MP/50MP/8MP rear cameras • 12MP front camera • Wi-Fi 7 • Bluetooth 5.4 • NFC • 5,000mAh battery • USB-C 3.2 Gen 2 connector • Android 15 (7 major updates) • 78 x 8.2 x 163mm (WDH) • 218g • 2yr RTB warranty

Samsung Galaxy S25

The cheapest route to Galaxy AI isn't a huge upgrade on last year's models but is still a great mid-range choice

SCORE ★★★★☆

PRICE 128GB, £666 (£799 inc VAT) from samsung.com/uk

While the Samsung Galaxy S25 Ultra (*see p70*) is a superlative smartphone, the regular Galaxy S25 provides a more affordable alternative – and may well be the smarter purchase.

The cost of admission to Samsung's ecosystem is much lower than the Ultra, starting at £799 for the 128GB edition or £859 with 256GB of storage, putting the S25 head to head with the Google Pixel 9 (*see issue 362, p58*) and the basic Apple iPhone 16 (*see issue 363, p68*). For those seeking something more substantial there's also the Galaxy S25+ variant, which has a larger 6.7in display and a bigger battery for an extra £140. Both models come in Icyblue, Navy, Silver Shadow and Mint finishes; if you buy directly from Samsung you can also choose Blueblack, Coralred or Pinkgold.

The Galaxy S25 is a fraction thinner and lighter than the Galaxy S24 it replaces, but with its flat sides, flat screen and three-camera back panel the family resemblance is unmissable. As before, there's Gorilla Glass Victus 2 on the back and front, and the IP68 rating for dust and water resistance remains.

The Galaxy S25 uses the same 6.2in 120Hz AMOLED display as last year's Galaxy S24 – but fear not, it holds up very well. It's brighter than the display on the iPhone 16, with better colour coverage, and colour accuracy is top notch: its average Delta E is 0.25.

The camera hardware is also the same as on last year's model, so you still get a 3x optical zoom. However, Samsung claims the S25's updated ProVisual Engine produces better photos, and I saw that in my test shots. Samsung phones used to produce super-saturated, almost cartoonish colouring, but here everything looks much more realistic. That can mean photos look drab, but it's a more honest representation, with plenty of depth and detail.

There are a few areas where the S25 lags behind the competition. The ultrawide camera has a low 12MP resolution by modern standards, though I still took several nice shots with it. The 3x telephoto is also outclassed by 5x zoom lenses found on rival phones costing a shade more.

On the plus side, I really like how the S25 handles selfie shots. I can clearly see more detail in the Galaxy S25's image compared to the same one taken on the Galaxy S24, and the tones of my skin, hair and clothing look much more natural.

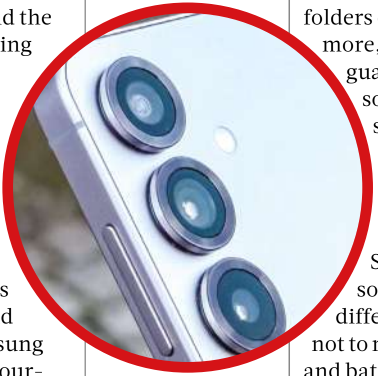
In video, the Galaxy S25's footage is shakier than the iPhone 16 Pro, but its superior dynamic range makes for more effective cinematography. You can shoot in 4K at 60fps or 8K at up to 30fps, and optionally enable Samsung Log format for easy colour-correction and exposure control during editing.

The processor in the Galaxy S25 is a Samsung-exclusive "For Galaxy" edition of the Snapdragon 8 Elite. This increases the performance of the already impressive silicon, and comes partnered with 12GB of RAM as standard. This powered the S25 to superb scores of 2,916 in the single-core Geekbench test and 9,886 for multicore operations – that's competitive with the iPhone 16 Pro, which scored 3,400 and 8,391 respectively.

LEFT The Galaxy S25 is a fraction thinner and lighter than the S24

ABOVE The S25 shares many of the attributes that make the S25 Ultra such a good buy

> "On paper the Galaxy S25 isn't a huge step up from the S24, but the new AI and software features make a big difference"



ABOVE While the cameras are the same as the S24, the photo processing is better

Performance is helped along by a new cooling system, designed to draw heat from the CPU and prevent throttling. The drawback is that the case became hot after a period of extended gaming.

Battery life is great for such a compact phone. The 4,000mAh battery lasted for 15hrs 43mins minutes of web browsing on a full charge, well beyond the iPhone 16 Pro's 14hrs 7mins and the Pixel 9 Pro's 13hrs 37mins. Topping up is reasonably quick, too: using the maximum 25W wired charging, I got from empty to 28% in 15 minutes, and there's 15W wireless charging too.

Aside from the hardware, the Galaxy S25 brings the same bevy of AI software features as the S25 Ultra. This means you can instruct Gemini to carry out multipart voice commands across multiple apps, and enable the smart Now Brief and Now Bar features described in our S25 Ultra review. Add in all the other little niceties – such as image-editing tools and call transcriptions – and the Galaxy S25 offers almost everything I've wanted from an AI-focused phone.

Other software updates include separate notification and quick settings windows, redesigned layouts for Samsung apps and an option for larger folders on the home screen. What's more, as with the S25 Ultra, it's guaranteed seven years of updates, so you can expect it to gain all sorts of capabilities until the end of January 2032 – a brilliant long-term deal.

On paper the Galaxy S25 isn't a huge step up from the S24, but the new AI and software features make a big difference to the user experience, not to mention upgraded performance and battery life – and if those don't tempt you, Samsung's best-ever photo processing might. Anyone in the market for a mid-priced phone should take a serious look at this speedy, reasonably priced and long-lasting offering. **RICHARD PRIDAY**

SPECIFICATIONS

8-core Qualcomm Snapdragon 8 Elite SoC ● 12GB RAM ● Adreno 830 graphics ● 6.2in 120Hz AMOLED screen, 1,080 x 2,340 resolution ● 5G ● 128GB/256GB/512GB storage ● dual nano-SIM ● IP68 ● triple 50MP/10MP/12MP rear cameras ● 12MP front camera ● Wi-Fi 7 ● Bluetooth 5.4 ● NFC ● 4,000mAh battery ● USB-C 3.2 Gen 2 connector ● Android 15 (7 major updates) ● 71 x 7.2 x 147mm (WDH) ● 162g ● 2yr RTB warranty

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SCAN ME

WALLPAPER IN BACKGROUND GRANDIFLORA ROSE, DESIGNERS GUILD
PHOTOGRAPHS (BACKGROUND) POLLY WREFORD

Honor Magic7 Pro

A superb phone thanks to its exceptional camera, speed and battery life – but the software won't suit everyone

SCORE ★★★★☆

PRICE £917 (£1,100 inc VAT)
from honor.com

The Magic7 Pro is a big phone with a big price, though it's cheaper than the iPhone 16 Pro Max (*see issue 363, p72*) or the Samsung Galaxy S25 Ultra (*see p70*), especially once you factor in the generous 512GB of storage that comes as standard. Perhaps it also makes a more individualist statement than those mass-market handsets.

Then again, the design isn't exactly a bold departure. The lateral curves of the Magic6 Pro (*see issue 356, p70*) have been ditched in favour of a boxier design with flat sides – a look very much in keeping with Apple's and Samsung's latest releases. However, the front and rear faces are more rounded, with symmetrical "micro curves" around the edges.

The feel is premium and inspires confidence, as does an IP69 rating for dust and water resistance: it will withstand both immersion in fresh water and jets of hot water up to 80 degrees. I'm not sure when that will ever come in useful, but if you want to scroll Instagram in the shower, you can. The phone comes in three colours, namely Breeze Blue, Black and Lunar Shadow Grey; the latter is the standout in my opinion, featuring a marble-like texture running across the back panel that becomes more visible as light catches it.

All options feature a velvety-feeling matte glass rear with a large, centrally placed circular camera block. This is surrounded by a "squircle"-shaped bezel, as on the Magic6 Pro, but it's less angular and conspicuous this time, for a more tasteful, sensible look.

Screen star

The Honor Magic7 Pro has a 6.8in display with a dynamic refresh rate that can shift from 1Hz to 120Hz as needed. It's mostly flat, but the curves around the bezels of the display create an impression like an overfilled glass of water. I quickly got used to this, and I like the way the curved edges feel in your hand.

The display is covered with Honor's NanoCrystal Shield glass; based on my long experience of using the Magic6 Pro I'm confident in saying this is one of the most scratch-resistant coatings in the business. It's also supposedly ten times more drop-resistant than traditional glass screens; I haven't tested that, but it's good to know, especially as there's no case included in the box.

When it comes to brightness, the Magic7 Pro has lumens to spare. It peaks at 5,000cd/m² in certain conditions, which means HDR content looks exceptional, and you'll never have trouble seeing it even in the brightest sunlight. It doesn't hurt that the display also features circular polarisation, which makes the screen slightly less reflective. Other eye-care features include the fastest pulse width modulation (PWM) dimming rate I've seen, topping out at 4,320Hz. In practice, that means you'll never have to worry about flicker on this panel. You can also activate custom eye comfort and low-blue-light modes to keep your peepers feeling fresh.

Under the display there's a 3D ultrasonic fingerprint sensor, and a 3D face-unlock camera behind a pill-shaped cutout at the top. Apparently, this is the first phone to come with both, and I find it very convenient to have the option.

Ups and downs

The main camera on the Magic7 Pro has a 50MP 1/1.3in sensor, and an aperture that switches mechanically between f/1.4 and f/2; the ultrawide and selfie cameras each have a 50MP resolution, too, along with f/2 lenses. These aren't particularly unusual specifications for a phone like this; the interesting part is the zoom camera, which combines a 3x telephoto lens and a large 1/1.4in sensor with a massive 200MP resolution.

Evidently the idea of having such a high resolution is to allow you to digitally zoom in well beyond the 3x optical magnification factor. It works well up to around 10x, but beyond that I began to see muddy, inconsistent results. If you push right up to 30x zoom, a feature called AI SuperZoom kicks in, which uses cloud computation to clean up and enhance your images; the results can be impressive, but they can also sometimes look weirdly washed out or even include digitally generated details that weren't there in reality. I was disappointed by this, as the Oppo Find X8 Pro (*see issue 365, p70*) has a similar feature that works rather better; Honor acknowledges that this feature is in its infancy, and suggests that it will mature and improve over time.

Another noteworthy camera feature is the Studio Harcourt portrait styles, as introduced last summer on the Honor 200 Pro (*see issue 359, p74*). If you like taking portraits this is a serious upgrade, with stunning colour tuning and blur effects that work even better on this top-tier camera hardware. Sadly, the feature is restricted to the main and telephoto cameras, so you can't use these effects on selfies.

In all, it's a fine camera system, capable of delivering outstanding shots in all lighting conditions, but it's not the most consistent. I found I got more blurry shots than I'm used to, and the image processing often pushed the sharpening too far, while blues and greens became exaggerated. Hopefully these problems can be ironed out with future software updates.

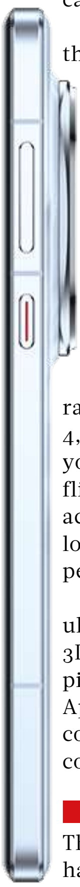
Silky silicon

The Honor Magic7 Pro is powered by Qualcomm's most powerful chipset, the Snapdragon 8 Elite, and comes with 12GB of RAM as standard. You won't be surprised, therefore, to learn that navigation is slick, apps whizz along, and gaming is beautifully smooth. I played *Genshin Impact* at maximum settings for a couple of hours, and the phone had no trouble maintaining a solid 60fps throughout, while remaining pleasantly cool.

ABOVE The Magic7 Pro is a fine alternative to flagship phones from Apple and Samsung

PC PRO RECOMMENDED

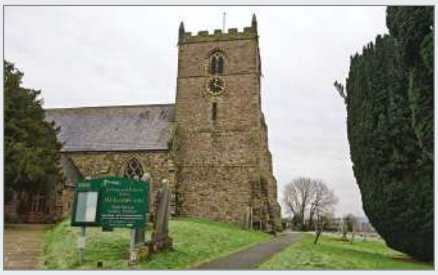
> **"The Honor Magic7 Pro has lumens to spare. It can peak at a whopping 5,000cd/m², which means HDR content looks exceptional"**



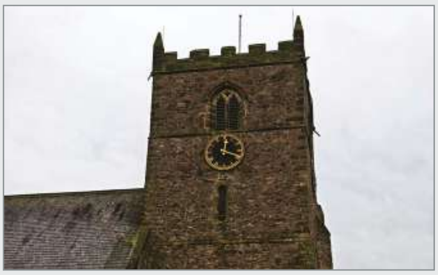
LEFT Build quality is exemplary, with strong dust and water resistance

Photo gallery

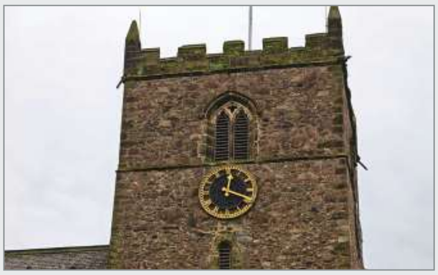
The Honor Magic7 Pro's high-resolution main camera allows you to digitally zoom in well beyond the 3x optical magnification factor – with impressive results



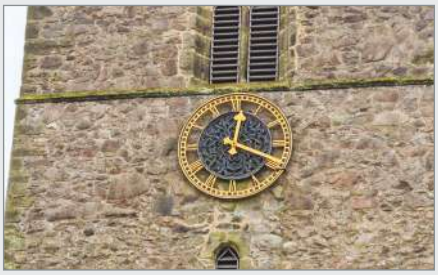
This establishing shot of a church tower shows how far away from the clock I was standing



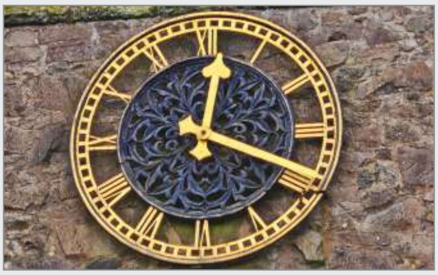
The 3x optical zoom takes me this close, exactly like a conventional phone with a zoom



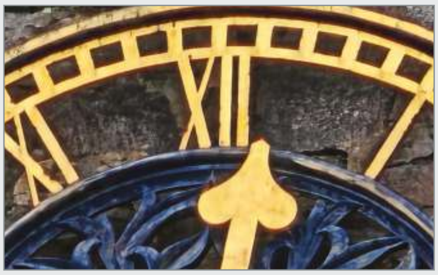
This is up to 5x zoom, and frankly there's no sign of this even if you examine the photo closely



The digital zoom works extremely well up to this point, 10x zoom, with no obvious sign that it's not optical



Here we are at 30x zoom, SuperZoom as Honor calls it, where AI-enhanced detail comes into play



Cropping closer into the photo, you can see that SuperZoom has (largely) done an admirable job

This may well be thanks to Honor's AI Predictive Scheduling Engine, which uses the onboard NPU to improve gaming performance. Via the built-in gaming overlay, you can use AI to dial up the image fidelity and frame rates without increasing the load on the GPU, which means less battery drain and lower temperatures.

The gaming experience is further enhanced by an excellent set of speakers. Believe it or not, this phone includes an integrated subwoofer along with an ultra-large sound cavity design, which really adds depth and power to in-game sound effects.

Magic OS tricks

The underlying system software is Honor's Magic OS, which can divide opinion. It's one of the most heavily customised versions of Android on the market, with lots of elements redesigned and moved around from their stock locations. This can be challenging if you're coming from a more traditional Android phone.

On the plus side, Honor heaps on plenty of extra functionality. My personal favourite is Magic Portal, which allows you to select text or an image on your screen and drag it into another app for quick sharing or searching. We've seen versions of this on previous Honor phones, but with the Magic7 Pro it's easier than ever, as you can now circle things to quickly select them.

AI-powered features include a translator tool, the ability to transcribe and format text notes with AI and an array of smart image-editing functions. As with most Android phones these days, you also get Circle to Search, with Google Gemini as the default voice assistant. And with a future update Honor says the phone will use AI to automatically protect you from deepfake video chats. I can't say I've ever received one, but the extra peace of mind is nice.

One big final plus point of the Honor Magic7 Pro is battery life. I was amazed to find the phone could get me through two days on a full charge, without making any effort to limit my screen time or app usage. That's partly down to a large 5,270mAh battery, but it surely also reflects impressive power management on Honor's part.

Recharging, meanwhile, is lightning fast: the Magic7 Pro can support a massive 100W wired charging rate, or 80W wireless with a compatible pad. Unfortunately, no charger, fast or otherwise, is supplied in the box, but you can buy a 100W USB charger online for less than £40, which will enable you to take the Magic7 Pro from flat to full in less than 35 minutes. Alternatively, the official Honor wireless SuperCharger costs £85 and will completely fill your battery in just under 45 minutes without a cable.

BELOW The superb selection of cameras includes a 3x telephoto lens with a massive 200MP resolution

LEFT There's support for 100W charging – not that you'll need to use it that often

Big value

The Honor Magic7 Pro is an outstanding phone that impresses in almost every area. The screen is one of the best around, performance is exceptional and the battery lasts longer and charges faster than most. Honor's software won't be to everyone's taste, and the camera software feels like it's not fully mature, but this is still one of the finest "flagship" phones available today – and better value than big-screen rivals, especially if you're looking for a phone with plenty of storage. **LUKE BAKER**

SPECIFICATIONS

8-core Qualcomm Snapdragon 8 Elite SoC ● 12GB RAM ● Adreno 830 graphics ● 6.8in 120Hz AMOLED screen, 1,280 x 2,800 resolution ● 5G ● 512GB storage ● dual nano-SIM ● IP69 ● triple 50MP/200MP/50MP rear cameras ● 50MP front camera ● Wi-Fi 7 ● Bluetooth 5.3 ● NFC ● 5,270mAh battery ● USB-C 3.2 Gen 2 connector ● Android 15 with MagicOS 8 (4 major updates) ● 77 x 8.8 x 163mm (WDH) ● 223g ● 2yr warranty

Lenovo Legion Go S

This 8in Windows 11 gaming handheld feels great in the hand, but it's too sluggish and expensive to recommend

SCORE ★★★☆☆

PRICE 16GB/1TB, £500 (£600 inc VAT) **from lenovo.com**

Lenovo
LEGION
Y
X
B
A

ABOVE The Legion Go S is a well-designed handheld that's comfortable to hold

The Legion Go S is a more compact sibling to Lenovo's original Legion Go handheld gaming PC (*see issue 352, p56*) – although with its 8in display it's still larger than rival handhelds such as the Asus ROG Ally and Steam Deck OLED. It also features an updated chassis and introduces AMD's new Ryzen Z2 Go processor.

I'm a big fan of the new design. I found the original Legion Go too bulky to hold comfortably for more than ten minutes, but that's not at all the case with the Legion Go S – it's both smaller and more ergonomically styled, with rounded grippy corners. While it's no longer possible to detach the controllers, as you could on the Legion Go, the comfortable shape and even weight distribution prevent it from being burdensome during extended gaming sessions.

The controls are nicely laid out, too. The analogue joysticks are positioned asymmetrically, similar to an Xbox controller, and the new circular D-Pad is a much better fit for fighting games than the Legion Go's cross-shaped pad. The L2 and R2 buttons have clever trigger locks that let you adjust each trigger's travel distance, so you can set a short action for rapid firing in *Call of Duty: Black Ops 6*, or a longer travel for fine control in *Dirt 5*, for instance. The two programmable back buttons are perfectly placed at the point where your middle fingers rest.

In addition to the main controls, there's also a small touchpad located below the right analogue stick, which you can use to control the mouse pointer. Its tiny size makes it fiddly to use, but you won't need to access it while actively gaming, and it's small enough not to get in the way.

AMD
RYZEN
Z2 Series

LEFT AMD's Ryzen Z2 Go chip struggles to provide the power for smooth gaming

Cool running

Another positive aspect of the new design is that it doesn't get uncomfortably hot, even during long, intense gaming sessions – in fact, it's remarkably cool. The warmest point I measured anywhere on the casing was 32°C, close to the centre of the rear vents, which is nowhere near your hands. At the same time, I was never bothered by the sound of the internal fans; the only time I even noticed them was when the system was downloading games or installing updates, and then they produced a whisper at most. This is one of the coolest, quietest handhelds I've reviewed.

Another strength of the Legion Go S is its screen. Its 1,920 x 1,200 resolution is very sharp, but thanks to its small size you can drop down to 1,280 x 800 and things still won't look blocky. It supports a smooth 120Hz refresh rate, and colours are rich and vibrant. As soon as I started trying out a few games I was struck by how the hellish landscapes of *Doom Eternal* and the neon-drenched streets of *Cyberpunk 2077* came to life in glorious detail.

Our labs tests back up this impression. The Legion Go S's screen delivers strong colour coverage and accuracy, and while it doesn't go quite as bright as rival handhelds such as the Asus ROG Ally X or the MSI Claw 8 AI+, it's close enough. My only complaint is that things could have looked even better if Lenovo had used an OLED display instead of cheaper LCD technology. Though not a deal-breaker, it's disappointing for the price.

Mixed reviews

A last plus point is Lenovo's slick, intuitive Legion Space game launcher. This makes it easy to browse and launch games from multiple gaming services, including Xbox, Epic Games and Steam. You can even purchase games from their respective storefronts directly within Legion Space, and access various system settings including performance mode, display resolution, refresh rate, controller mapping and hardware lighting effects. You can view any screenshots you've snapped, too, and check on your pending downloads.

> "Another strength of the Legion Go S is its screen. It supports a smooth 120Hz refresh rate, and colours are rich and vibrant"

Sadly, while the Legion Go S makes a great initial impression, once you start using it in earnest you quickly run into serious shortcomings. One is battery life: in our standard battery test, which involves continuous web surfing over Wi-Fi with the display set to 150cd/m², the Legion Go S ran for only 1hr 42mins on a full charge before shutting down. That's barely more than half as long as the Asus ROG Ally X, which managed 3hrs 4mins, and it's 40 minutes behind the MSI Claw 8 AI+ – so while the system is highly portable, don't expect to enjoy long gaming sessions on the move.

Stalling speeds

A bigger problem is the processor. It's no secret that the AMD Ryzen Z2 Go CPU is a less powerful chip than the Z1 Extreme used in the original Legion Go, but even knowing this I was

LEGION
Lenovo

BELOW The controls are well laid out, and the two back buttons can be programmed disappointed by the overall gaming performance of the Legion Go S.

For example, I started my testing with *Doom Eternal*, one of the most highly optimised games. At native resolution and medium graphical settings, I saw performance averaging at a miserable 25fps, even with the power-management options set to maximum performance mode. I had to drop the resolution to 800p and set the graphics quality to low to ensure the game ran at smoother 45fps.

Things were even worse in *Cyberpunk 2077*. Here, using the "Steam Deck" graphical preset, which is explicitly tailored to handhelds, I saw a measly 15fps. Even by further dialling down the resolution and graphical settings, the best frame rate I could coax from it was between 25 and 33fps, for an overall experience that fell a long way short of the game's potential. Clearly, you're not going to be getting the best from that 120Hz screen in any demanding games.

To get a sense of how this performance stacks up against other handheld gaming systems, I ran the in-game benchmarks in *Assassin's Creed Mirage*, *Cyberpunk 2077* and *Red Dead Redemption 2*. The results showed that the Legion Go S was generally a little behind the Asus ROG Ally X, while the MSI Claw 8 AI+ was a clear overall winner thanks to its Intel Lunar Lake processor. The Legion Go S also fell behind its rivals in regular CPU benchmarks. There's no mistaking this for a top-tier gaming system.

Final decisions

I've one final criticism of the Legion Go S, although Lenovo can't be fully blamed: in my experience, Windows 11 sucks as a platform for gaming handhelds. The OS has no accommodation for controller inputs, so for anything outside of the Legion Space launcher you'll have to use the tiny touchpad, push the mouse cursor around with the right analogue stick or prod the touchscreen directly. Whichever method you choose, it's not a particularly enjoyable experience on a screen this size; the good news is that Lenovo is working on a SteamOS version of the Legion Go S, which should provide a more integrated experience.

In all it's hard to recommend that anyone spend £600 on the Legion Go S. I can't complain about the ergonomic, cool and quiet design, nor the excellent 8in display or the easy-to-use launcher. At the end of the day, though, this is supposed to be a gaming device, and it just isn't powerful enough to fulfil that role satisfactorily. **TONY POLANCO**

ABOVE The triggers on the joystick buttons can be adjusted to suit the game

LEFT The Legion Go S at least remains cool, even during long gaming sessions

SPECIFICATIONS
4-core/8-thread AMD Ryzen Z2 Go processor ● AMD Radeon 700M graphics ● 16GB LPDDR5 RAM ● 8in 120Hz IPS touchscreen, 1,920 x 1,200 resolution ● 1TB M.2 PCIe Gen4 SSD ● microSD card reader ● Wi-Fi 6E ● Bluetooth 5.3 ● 2 x USB-C 4 ● 3.5mm combo jack ● 2 x 2W speakers ● 55.5Wh battery ● Windows 11 Home ● 299 x 128 x 22.6mm (WDH) ● 740g ● 1yr C&R warranty

---

Dell EcoLoop Premier Backpack 14-16

A high-quality offering with excellent cushioning for laptops, but you may find its capacity limiting

SCORE ★★★★☆

PRICE £64 (£73 inc VAT) from ballicom.co.uk

It's no surprise that Dell knows how to make excellent backpacks: it ships around 40 million laptops each year, and they need protection. It's been making backpacks for years, and this shows in the attention to detail here.

Crucially, your laptop will stay protected. There's heavy cushioning at the rear and the bottom, with a dedicated sleeve to prevent scratches from neighbouring items. Dell states that the largest laptop dimensions are 360 x 260 x 20mm, and the fractionally larger PCSpecialist Fusion 16 (*see p63*) slipped in easily.

The 23-litre backpack's capacity is spread across two main sections and two smaller pockets. The rear is for laptops or a tablet (it can be locked thanks to loops built into the zip sliders), the next for chargers and other bulkier objects, while I shoved my headphones, paper notebook and Kindle in the third. The fourth is only deep enough to hold passports and other slim items.

I found a childish joy in the multitude of zip pockets and semi-hidden hideaways, including a small zipped pocket for wallets that's hidden from view when you're wearing the backpack. Another delight: a pop-out holder for a water bottle or coffee cup that snaps shut when not in use thanks to magnets.

All this adds to the stylish, slimline look of the Premier Backpack, with subtle Dell branding in the leather effect tags (reminiscent of Levi's jeans). The EcoLoop part of the name is due to Dell's use of recycled polyester, reducing water impact and greenhouse gas emissions, a dyeing process that again avoids water usage, plus the use of ocean-bound plastic. While the most eco-responsible choice is always to reuse existing products, at least Dell is thinking about its environmental impact. It's also reassuring to see a three-year warranty, suggesting Dell has faith in the quality of its product.

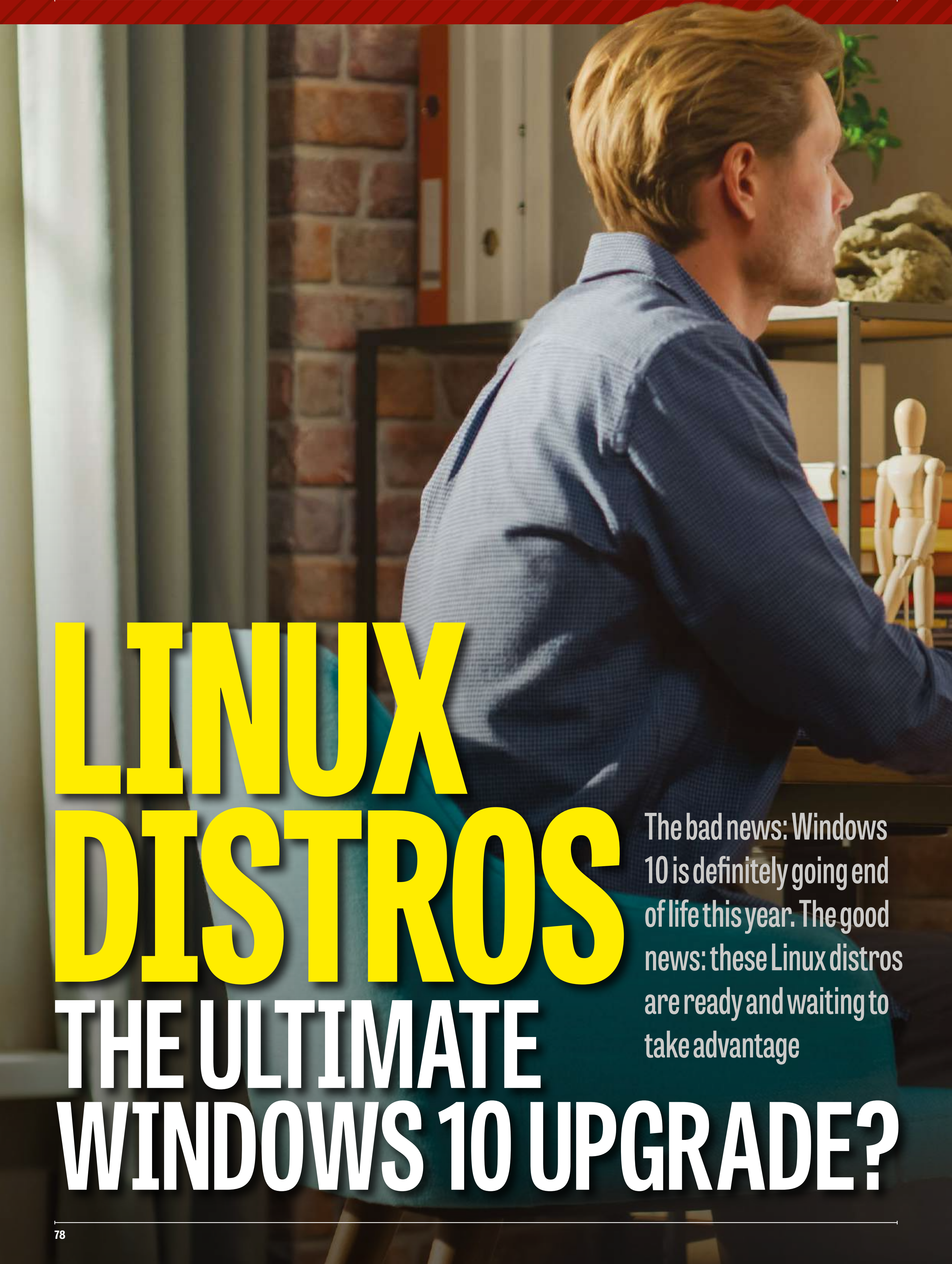
Before you buy, note that the backpack was – at the time of writing – far cheaper if bought from Ballicom than Dell, where it sells for £99 inc VAT, and that if you're the type of person who stuffs heaps of extras in your bag then you'll find its capacity restrictive. Especially as those 23 litres are spread across several pockets, rather than one big section. It's also relatively heavy at 930g, due in part to all the cushioning. But if it meets your travelling needs, the EcoLoop Premier Backpack is a top-quality choice. **TIM DANTON**

ABOVE Cushioning at the rear and the bottom provides plenty of protection

PC PRO RECOMMENDED

LEFT The backpack has a capacity of 23 litres and will easily hold a 16in laptop

SPECIFICATIONS
23-litre total capacity ● max laptop dimension (stated): 360 x 260 x 20mm ● 300 x 180 x 440mm (WDH) ● 930g ● 3yr limited warranty ● part code CP7625



LINUX DISTROS

THE ULTIMATE WINDOWS 10 UPGRADE?

The bad news: Windows 10 is definitely going end of life this year. The good news: these Linux distros are ready and waiting to take advantage

We kicked off our last Linux Labs (*see issue 354, p78*) with an admission: that despite its success in the server space, Linux ran just 3% of all desktops. Windows machines outnumbered Linux by 20 devices to one. But, we said, "its future looks bright" – and we were right.

Its user base has grown by 50% since, and it's on course to touch 5% of all desktops in the first quarter of 2025. This isn't surprising. The increasing popularity of single-board computers like Raspberry Pi is putting Linux into the hands of a whole new generation of users while computers are lasting longer than ever before.

Combine hardware longevity with Microsoft's desire to end support for Windows 10 – it goes end of life on 14 October unless you're willing to spend £24 for a year's worth of updates – and you have two excellent reasons to consider a switch to Linux.

To put this thought to the test, we bought a second-hand Dell OptiPlex 3060 specifically for this Labs. With an Intel Core i5-8500T processor, integrated graphics, 8GB of memory and a 256GB SSD, it's no longer cutting edge, but it's precisely the kind of machine that would suit a first-time Linux user well.

Buying second hand means you can choose a Linux workstation that exactly suits your requirements, and it also reduces your environmental impact. The costliest periods of a computer's lifecycle, from an ecological perspective, are when it's produced and disposed of. The longer you can keep one running between those two moments, the lighter the carbon footprint will be when averaged across the years.

Encouraging someone to switch to Linux on environmental grounds used to mean an acknowledgment that doing so involved making some compromises. In particular, usability and functionality. That's no longer true. Linux is flexible, fast and easy to use, and with more and more applications running in the cloud, the times when you can't do what you need will be fewer – and definitely far between.

Don't believe us? Download one of these eight distributions and see for yourself.

CONTRIBUTOR Nik Rawlinson

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What is a Linux distribution anyway?

Linux works in a quite different way to Windows, so to make an informed choice you need to understand how all the components of a distribution fit together

If you're coming from Windows or macOS, where the operating system name is all you need to know, you might be wondering what exactly a Linux distribution is, how a display server differs from a desktop environment, and where apps and packages fit into the mix.

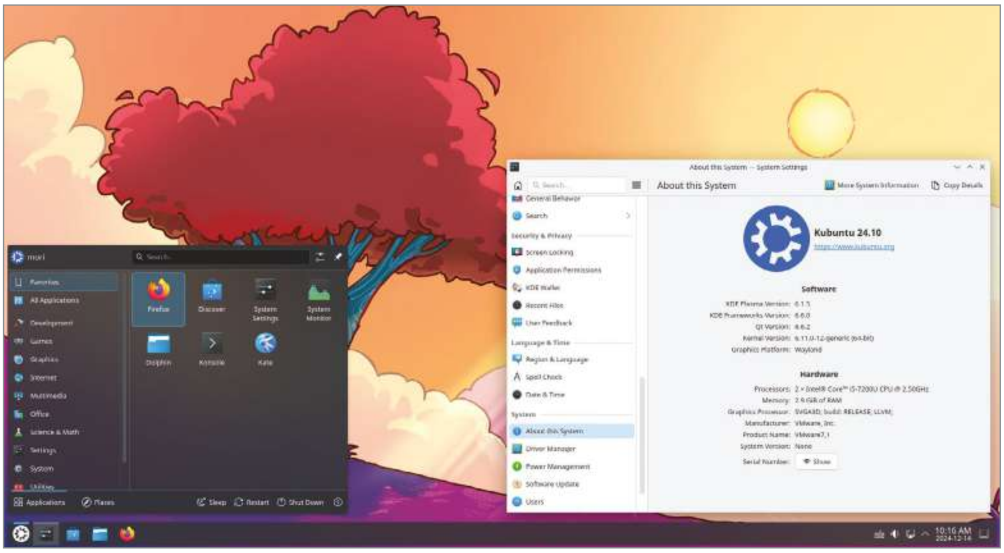
A distribution – often shortened to distro – is the overarching operating system, including the kernel, the graphical interface, the code that interfaces between different hardware elements and so on. As such, while we might consider Ubuntu, Fedora, Mint and the like to be "distros", your Ubuntu distro might be significantly different to ours.

Desktop environment

Unless you spend a lot of time working at the Terminal, most of your interaction will be through the desktop environment. In Windows, that would be the Windows Shell, which manages the operating system's graphical front end. Linux brands will frequently guide you towards their preferred environment – Gnome for Fedora, KDE for Manjaro, Cinnamon for Linux Mint – but it's rare that you can't switch to another if you prefer. Ubuntu alone is available with KDE (as Kubuntu), LXQt (as Lubuntu), Budgie, Mate, Cinnamon, Xfce and others. So, if you're switching from one distribution to another, there's no reason why your new operating system can't look and behave very like the one you're leaving behind.

But the desktop environment is only half of the story. The "environment" is effectively a series of packages that define the look of panels, onscreen buttons, window borders and so on. It can't directly interface with the screen on which they'll be displayed. Rather, it hands off what it's produced to the graphical server, which is sometimes also referred to as the display server. This takes the data from the desktop environment and arranges it on the screen, while also receiving input from the mouse and keyboard.

For many years you'd be unlikely to come across any graphical server other than X11, but that's changing. X11 first appeared in the 1980s, since when hardware has undergone several significant changes. Over time, therefore, X11 has been added to, as a result of which it has become more complex. Not so with Wayland, which looks increasingly like becoming its logical replacement.


About this System – System Settings

About this System

Kubuntu 24.10

https://www.kubuntu.org

Software

KDE Plasma Version: 6.1.5
KDE Frameworks Version: 6.6.0
Qt Version: 6.6.2
Kernel Version: 6.11.0-12-generic (64-bit)
Graphics Platform: Wayland

Hardware

Processors: 2 × Intel® Core™ i5-7200U CPU @ 2.50GHz
Memory: 2.9 GiB of RAM
Graphics Processor: SVGA3D; build: RELEASE; LLVM;
Manufacturer: VMware, Inc.
Product Name: VMware7,1
System Version: None
Serial Number: Show

More System Information
Copy Details
General Behavior
Search
Security & Privacy
Screen Locking
Application Permissions
KDE Wallet
Recent Files
User Feedback
Language & Time
Region & Language
Spell Check
Date & Time
System
About this System
Driver Manager
Power Management
Software Update
Users
Favorites
All Applications
Development
Games
Graphics
Internet
Multimedia
Office
Science & Math
Settings
System
Utilities
Firefox
Discover
System Settings
System Monitor
Dolphin
Konsole
Kate
Applications
Places
Sleep
Restart
Shut Down
10:16 AM
2024-12-14

ABOVE Ubuntu is available with a range of environments, including KDE

If most of your time will be spent interacting with its graphical front end, it doesn't really matter how it's delivered

Wayland first appeared around 16 years ago and is simpler, so should exhibit lower latency. It's not fully supported by all applications, which is why X11 remains the default on some distributions, while others allow you to switch between the two.

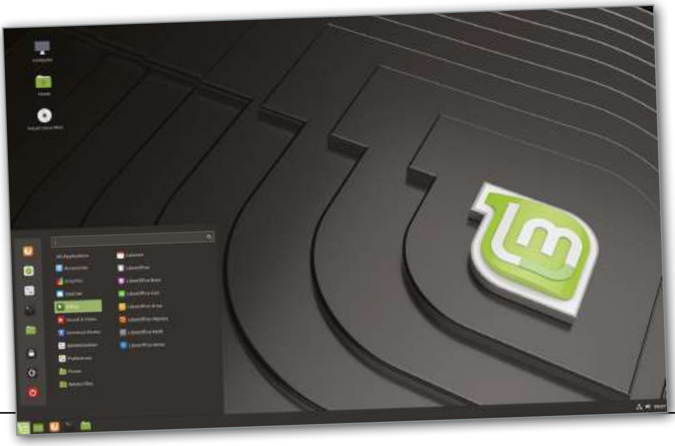
Putting it all together

If you're having trouble visualising how everything fits together, imagine a school art room. The room itself is analogous to a Linux distribution, as it has easels, tables, chairs, lighting, tools and materials – and everything else required to conduct an art lesson, all contained in a single location. Within it sits the canvas, on an easel. As the medium on which the artwork will be hosted, we can liken the canvas to the graphical server. It's not the artwork itself, but an essential facilitator. Without it, there would be no art.

Finally, there's the artwork, which the students will produce on the canvas, using the brushes and so on present in the room. The desktop environment is like a style guide for this artwork, which strongly influences how the tools are used to produce the end product. The end result might look like a Picasso or a Mondrian, or something entirely original. That doesn't really matter: scrape away the surface and there's still a canvas underneath.

It doesn't really matter what the art room looks like, what language the teacher speaks, how old the students are or what materials they use. All that matters is the end product, and whether you, as the viewer, like the look of it. The same is true of a distribution. If most of your time will be spent interacting with its graphical front end, it doesn't really matter how it's delivered so long as the overall distribution is secure and it gives you access to the apps you need.

BELOW Cinnamon is the preferred environment for Linux Mint



		RECOMMENDED	RECOMMENDED					LABS WINNER
	ElementaryOS	**Fedora Workstation**	**Linux Mint**	**Manjaro**	**MX Linux**	**openSUSE Tumbleweed**	**Pop!_OS**	**Ubuntu Desktop 24.10**
Overall rating	★★★☆☆	★★★★★	★★★★☆	★★★☆☆	★★★☆☆	★★★★☆	★★★★☆	★★★★★
Download from	elementary.io	fedoraproject.org	linuxmint.com	manjaro.org	mxlinux.org	get.opensuse.org	pop.system76.com	ubuntu.com
Current version	8.0	41	22.1	24.2	23.5	Updated daily	22.04	24.10
Release date	November 2024	October 2024	January 2025	December 2024	January 2025	On day of download	April 2022	October 2024
Technical details								
Release model	Periodic	Rolling updates	Periodic	Rolling updates	Periodic	Rolling release	Periodic	Periodic
Family	Debian	Red Hat	Debian	Arch	Debian	SUSE	Debian	Debian
Architecture	x86_64	x86_64, aarch64, ppc64le	x86_64 (i686 support for LDME edition)	x86_64	x86_64, i686	x86_64, 9686, ppc64le, aarch64, s390x	x86_64, Raspberry Pi (as tech preview)	x86_64, Arm64, ppc64le, s390x
Editions	Desktop	Desktop, server, IoT, cloud, container	Desktop	Desktop, phone/ embedded	Desktop	Desktop, server	Desktop	Desktop, server, core, cloud
Linux kernel	6.8	6.11	6.8	6.12	6.1	Latest available kernel at point of download	6.9	6.11
Download size	3.2GB	2.3GB	2.8GB	4GB	2.2GB	4.3GB	2.48GB	5.3GB
Installer	Custom based on Ubiquity	Anaconda	Ubiquity	Calamares	Custom	YaST	Custom	Ubiquity
Desktops	Pantheon	Gnome, KDE Plasma, Cinnamon, Mate, Xfce	Cinnamon, Xfce, Mate	KDE Plasma, Xfce, Gnoma, Cinnamon, i3 Window Manager, Sway VM	Xfce, Plasma, Fluxbox	KDE Plasma, Gnome, Xfce, IceWM, Cinnamon, Mate, Pantheon	Cosmic	Gnome (alternative desktops available from affiliated projects)
End of support	Underlying Ubuntu 24.04 LTS supported until 2029	13 months after release	April 2029	No end date as this is a rolling release	June 2026	No end date as this is a rolling release	April 2027	July 2025
Geekbench 6 results								
Single core	1,169	1,121	1,166	1,217	1,240	1,215	1,161	1,152
Multicore	3,969	3,185	3,991	3,957	4,078	3,962	3,954	3,543
Requirements								
CPU	Core i3 or comparable dual-core 64-bit processor	Not stated	Not stated	Dual core	i686 or later	2GHz dual core	64-bit	2GHz dual core
Memory	4GB	4GB	4GB	4GB	2GB	2GB	4GB	4GB
Storage	32GB	40GB	100GB	30GB	20GB	40GB	16GB	25GB
Display	1,024 x 768 resolution display	No minimum requirement specified	1,024 x 768 resolution display	High-definition graphics card and monitor	3D-capable video card (no minimum resolution specified)	No minimum requirement specified	No minimum requirement specified	No minimum requirement specified

How to install Linux

Whether this is the first time you've installed a Linux distro or you're a veteran, our step-by-step guide provides all the information you need

Most Linux distributions are free to download and install. All you need to get started is an ISO and a thumb drive to host the installer.

1. DOWNLOAD BALENAETCHER

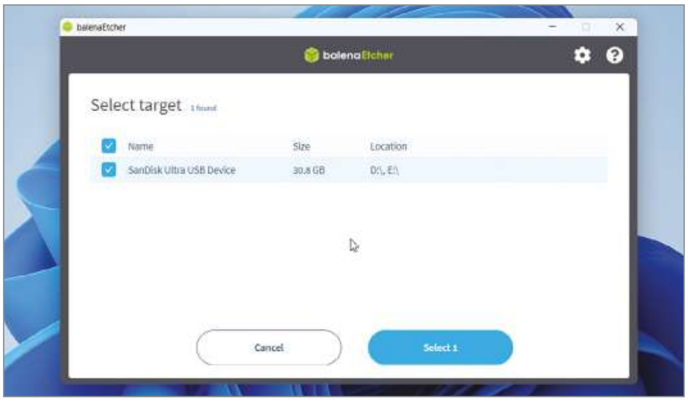
Install BalenaEtcher from **etcher.balena.io**. Once you've decided which version of Linux you want to install, download an ISO of its desktop, workstation or client edition. Frequently, each will be available for a variety of processor architectures, so make sure you choose the appropriate distribution for your PC, which will almost certainly be marked as x86_64, x86-64 or AMD64.

2. SELECT THE DISTRO AND DRIVE

Plug in your USB thumb drive and, once it's mounted, switch to BalenaEtcher. Click "Flash from file" and select the ISO you downloaded in the previous step. Next, click "Select target" and choose your USB thumb drive. Note that it's possible to select multiple drives simultaneously, so make sure you've chosen the right one, then click "Select 1". Check that the correct ISO and drive are shown on the BalenaEtcher homescreen, then click Flash. Windows will pop up a User Account Control dialog asking whether you want to authorise it to make changes. Allow this, and the process will begin.

3. CONFIGURE YOUR BIOS

Extracting the ISO and writing it to your USB drive should take less than five minutes. Once the process has completed, eject the drive and plug it in to the machine on which you want to install Linux. Start or reboot it, then press the button that either directs it to start from an external drive or opens the BIOS or UEFI. This is usually shown briefly during the boot process. If it isn't, common options are F2, F10, F11 or F12. Search online for your specific motherboard or computer manufacturer if you're not sure which to use on your machine.



Select target 1 found

	Name	Size	Location
☑	SanDisk Ultra USB Device	30.8 GB	D:\, E:\

ABOVE **Your first step is to download BalenaEtcher**

4. SET YOUR STARTUP DRIVE

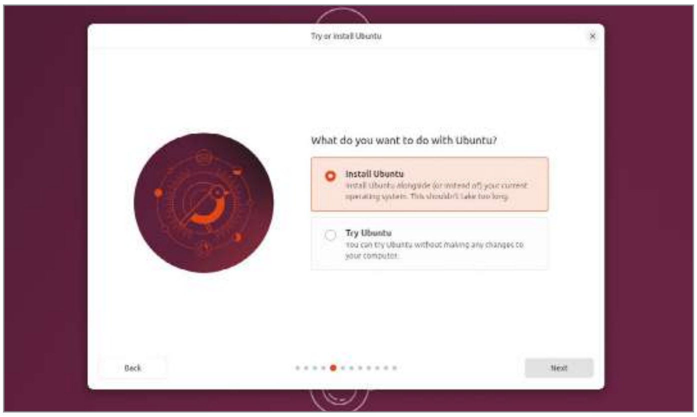
When you've entered the BIOS or UEFI configurator, navigate through its screens until you find an option for setting your boot device. Give priority to your USB-mounted flash drive, save any changes, then exit. Your PC will reboot again. What happens next depends on the build of Linux you're installing. Some will launch a dedicated installer immediately, but many will initiate a live environment in which you can use most of the operating system's features directly. This may be overlaid by a dialog offering to install the OS, or there may be a shortcut to this on the desktop. In either case, initiate the process.

5. INSTALL LINUX

The first few screens of the installation process usually ask you to specify your installation language and keyboard layout. You'll also be asked to set up your network connection if you're not plugged in via Ethernet. You can skip the network step, but we'd recommend following through as it will allow the installer to check whether it can update itself, and to download additional components and options such as third-party codecs that might not be included in the original bundle because they don't have an open-source licence. You will usually be asked whether you want to download these add-ons. We always opt to do so but, depending on how you feel about closed versus open-source code, you'll need to make your own decision.

6. PARTITION YOUR DRIVE

You now need to decide whether you want to install Linux alongside an existing operating system or wipe the drive and install it solo. Either way, make sure you have an up-to-date backup of the original OS from which you can restore should something go wrong when repartitioning the drive. The length of time installation takes can vary significantly, based on the speed of your PC, the speed of your thumb drive, the size of the distro you're installing and whether it needs to download any additional resources. When the process has finished, reboot your PC and, unless prompted to do so earlier, remove the USB flash drive immediately after restart so it's not used as your boot source.

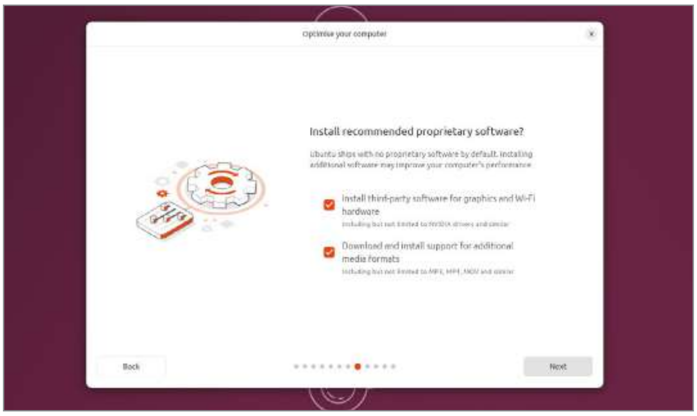


What do you want to do with Ubuntu?

● Install Ubuntu
Install Ubuntu alongside (or instead of) your current operating system. This shouldn't take too long.

○ Try Ubuntu
You can try Ubuntu without making any changes to your computer.

ABOVE **You can choose whether to install Linux or simply try it out**



Install recommended proprietary software?

Ubuntu ships with no proprietary software by default. Installing additional software may improve your computer's performance

☑ Install third-party software for graphics and Wi-Fi hardware
Including but not limited to NVIDIA drivers and similar

☑ Download and install support for additional media formats
Including but not limited to MP4, MP3, MKV and similar

ABOVE **You will usually be asked if you want to install additional software**

Portable distributions

One of the great things about Linux is that you can carry it with you on a USB thumb drive. Here's how

Linux can run from a USB drive as well as it does from an SSD. You can test most distributions this way before you commit them to internal storage.

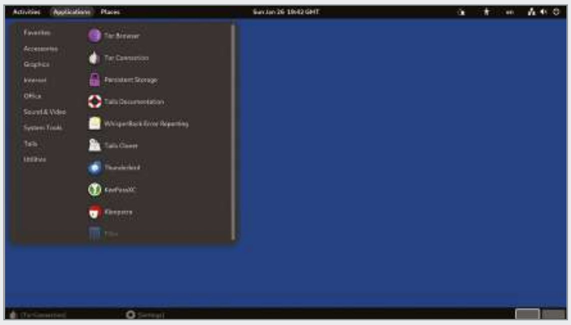
But why stop there? Running an operating system entirely from a USB thumb drive makes it uniquely portable. You can carry it with you if you travel and, so long as you aren't blocked by the host machine's Secure Boot settings, use it to start any device meeting the distribution's minimum spec. Whether that's a friend's old Intel Mac or your Airbnb's ageing PC, you won't risk damaging their setup, nor leaving behind any of your personal data.

Many distributions make a virtue of this.

Head for Tails

The Amnesic Incognito Live System (Tails) is a Debian-based distribution that's designed to live permanently on a USB thumb drive to combat online surveillance and give users a degree of anonymity. It's popular among activists, journalists and anyone who needs to communicate without being observed, such as survivors of domestic violence. It's designed to work on the widest possible range of machines in everyday use, so provided that your PC is less than ten years old and has a 64-bit processor and 2GB of memory, you should be okay. It works on some Intel Macs, but Apple processors and Raspberry Pi aren't supported.

ABOVE You can run Linux entirely from a USB thumb drive


Activities
Applications
Places
Favorites
Accessories
Graphics
Internet
Office
Sound & Video
System Tools
Tails
Utilities
Tor Browser
Tor Connection
Persistent Storage
Tails Documentation
WhisperBack Error Reporting
Tails Cloner
Thunderbird
KeePassXC
Kleopatra

RIGHT Tails is designed to protect your identity and to reset every time it's launched

When you boot Tails, it launches a live system that routes its outgoing traffic through the TOR network. TOR, which was developed in the 1990s by the United States Naval Research Laboratory, bounces data through multiple machines on the way to and from the requested resource, which can help to obscure your identity and location. Once you've finished your work, you shut down the distro in the usual way, at which point everything is reset, so the next time you boot, you're back to square one. In theory, this should keep your data safe, even if you lose the USB stick hosting your Tails environment, but it's not always a convenient way of working.

So, Tails has introduced persistent storage, which lives in a passphrase-protected, encrypted area on the USB stick. If anyone should guess your passphrase, they could decrypt the contents, which is why Tails recommends using between five and seven random words to define it. And, if you don't need to reference the contents of your persistent storage during a particular session, you can simply choose not to unlock it.

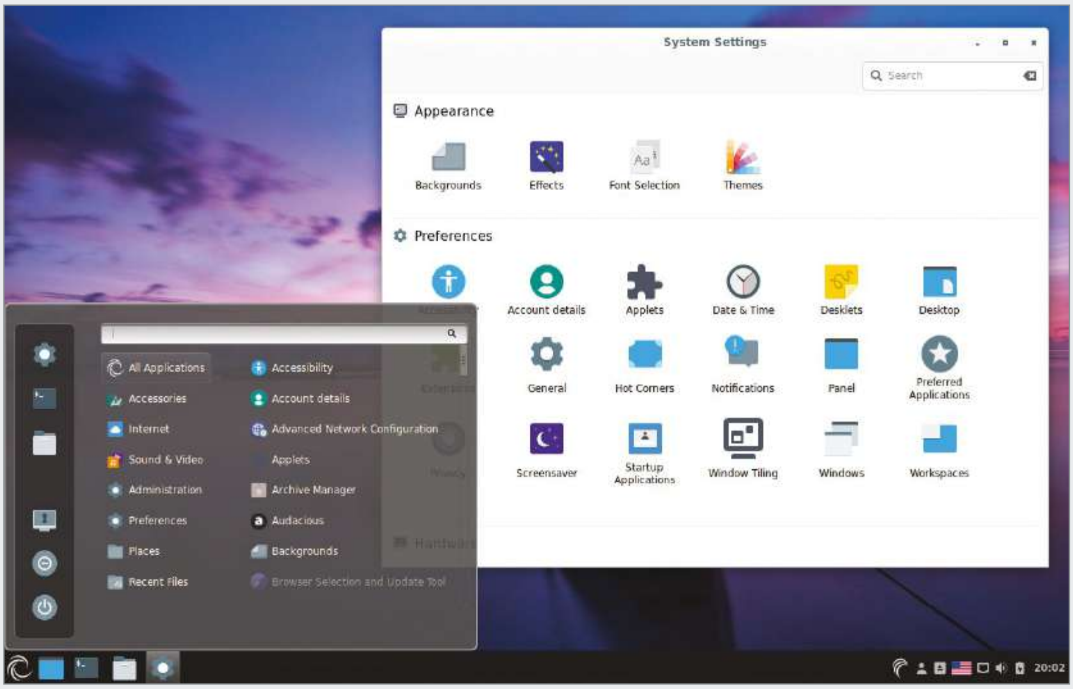
Tails is a free download from **tails.net** and can be installed on an 8GB or larger USB stick, or a recordable DVD.

Beyond Tails

Tails isn't the only USB-based distribution. Porteus (**porteus.org**) is a dedicated portable Linux, as its name might suggest, which needs just 300MB of drive space, so it's the ideal use for a decades-old stick for which you no longer have any use. Just make sure that your stick isn't approaching the end of its usable life. Porteus boots in a matter of seconds, supports 32-bit hardware and is flexible, giving you a choice of seven desktop environments. Unlike Tails, it writes data to the host stick, so changes you make in one session will reappear in the next.

Slax Linux (**slax.org**), which dubs itself a "pocket operating system", is likewise designed to run from USB full-time. It goes beyond offering different desktop environments, with a choice of underlying distributions: Slackware or Debian. The latter may be more familiar for anyone with experience of Ubuntu and Ubuntu-derived distributions. There are 32- and 64-bit builds, which require just 128MB of RAM to run the desktop, or 512MB if you want to launch the browser.

Of course, it's not all sweetness and light. While portable operating systems have their place, we wouldn't recommend using them on a daily basis if you have any way of instead running a fully installed distribution. Booting from USB often involves interrupting the host machine's regular boot sequence, which can require some quick reactions and BIOS/UEFI tweaking. A USB-based OS is also unlikely to perform as well as one that lives on a hard drive or SSD purely on account of the media on which it lives.


System Settings
Search
Appearance
Backgrounds
Effects
Font Selection
Themes
Preferences
Account details
Applets
Date & Time
Desklets
Desktop
General
Hot Corners
Notifications
Panel
Preferred Applications
Screensaver
Startup Applications
Window Tiling
Windows
Workspaces
All Applications
Accessories
Internet
Sound & Video
Administration
Preferences
Places
Recent Files
Accessibility
Account details
Advanced Network Configuration
Applets
Archive Manager
Audacious
Backgrounds
Browser Selection and Update Tool
20:02

ABOVE Porteus is a lightweight distro designed specifically to run from a USB drive

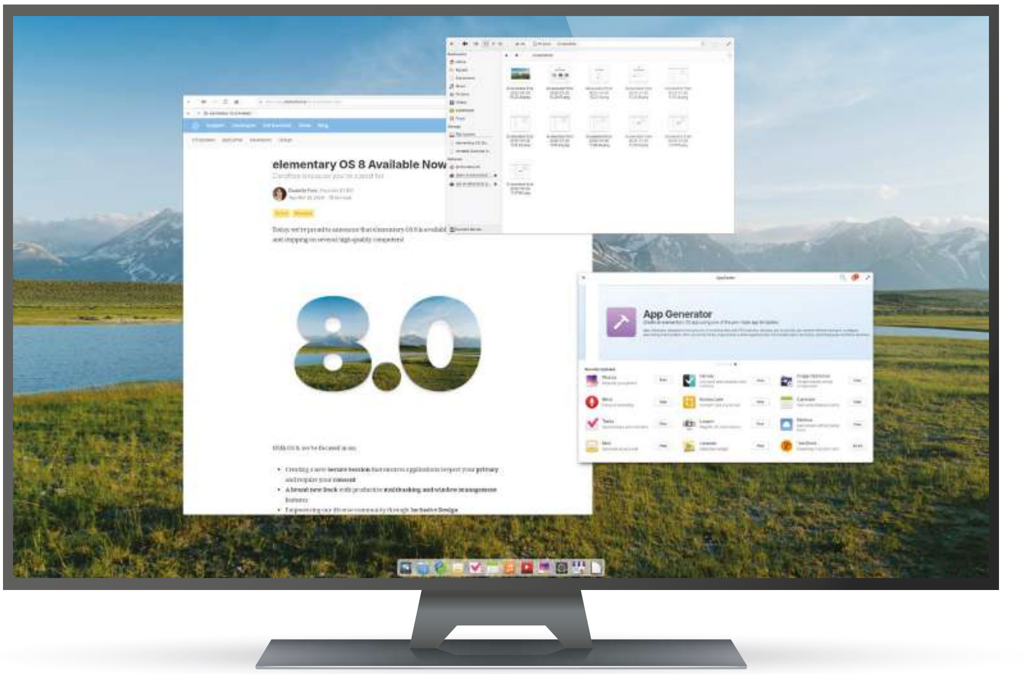
ELEMENTARY OS 8

A good-looking distro designed with security in mind, but we'd be tempted to run with Pop!_OS instead

SCORE ★★★☆☆

WEBSITE elementary.io

64-BIT DUAL CORE CPU | **4GB** MEMORY | **32GB** DISK SPACE



ABOVE Elementary uses its own Pantheon interface on the Gala window manager

Elementary pitches itself as a thoughtful, capable and ethical replacement for Windows and macOS. Currently at version 8, it's based on Ubuntu LTS 24.04.1 and offered on a pay-what-you-can basis (if that's nothing, enter zero in the box on the download page). LTS 24.04 is the most recent long-term Ubuntu release. It shipped in April 2024, which makes it two years younger than the Ubuntu LTS 22.04 on which Pop!_OS is based. It will continue to receive support until August 2029.

Elementary OS looks nothing like Ubuntu, and even if you're familiar with the OS on which it's based, you might need a little time to find your bearings. Installation is quick and easy, with account creation and language selection handled after first boot. At that point, you can also select the colour scheme and optionally set Elementary OS to automatically delete screenshots, downloads, temporary files and the contents of the bin every 30 days – in part to save space, but equally to protect your privacy.

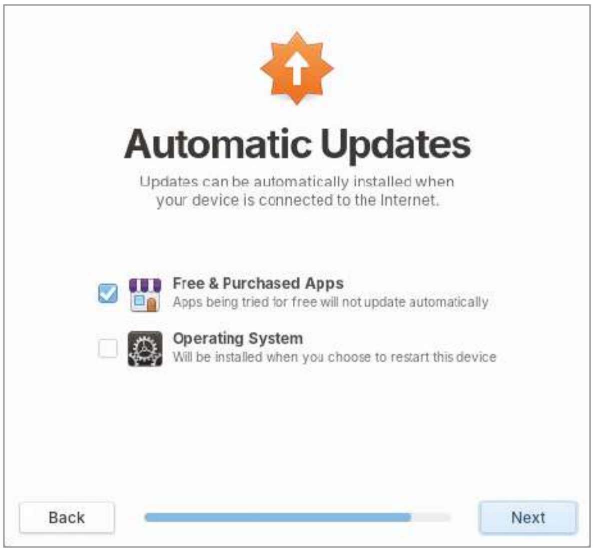
Indeed, Elementary was clearly developed with privacy in mind, and version 8 introduces a significant new feature: Secure Session. You enable this from the login dialog (by clicking the cog before entering your password) and it will use the Wayland display protocol to more tightly control how apps communicate. It also forces applications to labour under additional restrictions over their access to your camera, keystrokes and so on.

The developer claims that the narrow selection of pre-installed apps is "carefully considered", but it's lacking what we would consider some essentials, such as LibreOffice, and desirables such as the GIMP. You can install them from the App Center (which has Flatpak and Flathub support), or from the console, where Elementary OS uses the APT package manager.

The default browser, called Web, identifies as Safari 17, with Pantheon Mail the pre-installed email client. You can install Firefox, Chromium and Thunderbird from the App Center if you prefer. The desktop environment, Pantheon, runs on top of the Gala window manager

There were 103 updates ready for download during our first session. However, you can neatly opt in to automatic updates for free and purchased apps (pre-selected) and the operating system (not pre-checked) as part of the onboarding process. OS updates are applied when you reboot.

Our network hardware was set up as part of the installation process, and our wireless networks were visible on first boot. The five Samba shares running on our local network each showed up in the Files app, allowing us to navigate to them without manually entering hostnames. Our networked printer was likewise detected without us having manually installed any drivers.


Automatic Updates

Updates can be automatically installed when your device is connected to the Internet.

☑ Free & Purchased Apps
Apps being tried for free will not update automatically

☐ Operating System
Will be installed when you choose to restart this device

BELOW It can be set to automatically update your apps and OS during the onboarding process

The Settings app includes several handy features, including a screen time and limits section for anyone setting up a PC for kids (or for personal use if you need to impose some self-discipline). Further, while our monitor was correctly identified, the controls went beyond simple resolution and scaling settings seen elsewhere to offer colour deficiency assistance. This adjusts the entire colour palette to correct for protanopia, tritanopia and other tone-related issues, making this a sensible choice for anyone affected.

> **Elementary OS is an attractive offering and we welcome its use of the latest LTS release of Ubuntu and its thoughtful assistive technologies**

You can also set the display to greyscale to help with colour blindness. We found this mode relaxing for general use, but be aware that the effect is applied across the entire UI, including any images displayed on web pages and colour in documents, rather than just to interface elements. For more serious visual impairments, the operating system's built-in screen reader is easily accessed from the corner menu, where you can also invoke dark mode and the onscreen keyboard.

Elementary OS is an attractive offering and we welcome both its use of the latest LTS release of Ubuntu and its thoughtful assistive technologies. However, we didn't feel entirely at home the way we did in other distros, such as Fedora and Ubuntu – and, if we were looking for something significantly different to the "norm", we'd more likely opt for Pop!_OS.

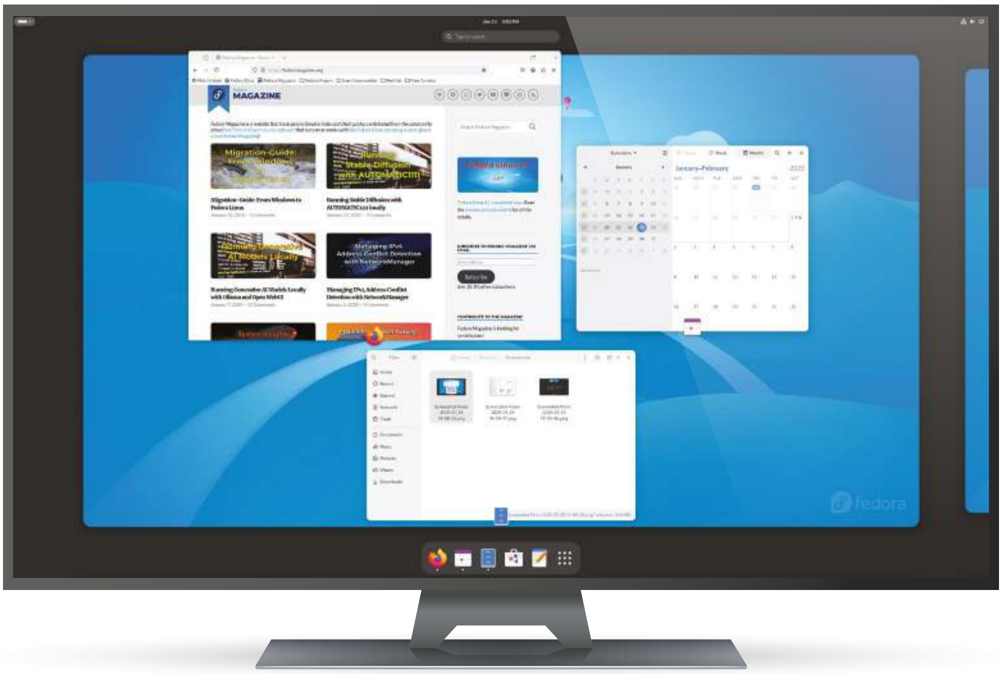
FEDORA WORKSTATION 41

This Red Hat-sponsored distribution is now over 20 years old, making it a rock solid choice

SCORE ★★★★★

WEBSITE fedoraproject.org

NOT STATED CPU · 4GB MEMORY · 40GB DISK SPACE


MAGAZINE
Migration Guide from Windows
Stable Diffusion with AUTOMATIC1111
Running Generative AI Models Locally
Managing IPv4 Address Conflict Detection with NetworkManager
January–February
2025
fedora

ABOVE Fedora's implementation of Gnome is clean and attractive

Fedora celebrated its 20th birthday in 2023, which makes it one of the longest-established distros on test. It has an impressive heritage, with roots in the Red Hat Linux project. The association continues to the present day, with Red Hat employees contributing to Fedora's development, Red Hat itself sponsoring Fedora, and – in a virtuous circle – innovations rolled out in Fedora feeding back into Red Hat Enterprise Linux. If you use Red Hat in a business environment, it therefore makes a lot of sense to opt for Fedora at home.

A new build is released roughly every six months and supported for 13 months, so this is a distro that refreshes regularly but doesn't require an update (patches aside) more than once a year if you're looking for stability. It uses the 6.11 Linux kernel. At the time of writing the latest stable release is 6.12.10.

You can download the ISO directly for Intel and AMD x86_64 systems, Arm aarch64 devices and Power ppc46le systems, but we'd recommend using the Fedora Media Writer. Stick with the default options and this will walk you through the process of downloading the latest build and writing it to a bootable USB stick. Eject it when it's finished, boot your target machine, then use the graphical Anaconda installer. This is the same installer as used by CentOS, Rocky Linux and Red Hat, and is logical and well thought through. You'll set up your user account and location on first boot.

As with each of the distros on test, we set up Fedora Workstation with Ethernet connected so it could get online and download any additional packages it required. Wi-Fi was ready to use on first boot, and our network printer was detected without us manually installing any drivers. The five Samba shares running on our network were also detected and advertised in the Files app, so we could access them without manually entering their local addresses.

Fedora Workstation 41 runs the Gnome 47 desktop environment on Wayland. A welcome move, as Wayland is increasingly replacing X11, with the promise of greater efficiency, flexibility and security. Gnome, meanwhile, is attractive, logical and again flexible – and the Adwaita icons and cursor pack employed here are clean and smart. The default system font is Cantarell, which gives this build a lighter feel than some Gnome-based implementations. You can pin your most used apps to a Dock, macOS style, to which Windows switchers should have no trouble adapting, and you'll probably want to install Gnome Tweaks so you can enable maximise and minimise controls on your app windows. Overall, it's a pleasant, calming and attractive environment in which to spend your working day.

If you don't like Gnome, you can install a range of alternative desktops, including KDE Plasma, Cinnamon (as used by Mint), Mate and Xfce (as used by MX Linux). To do so, select Spins in the Media Writer when asked which release you want to install, and pick your option from the drop-down menu.

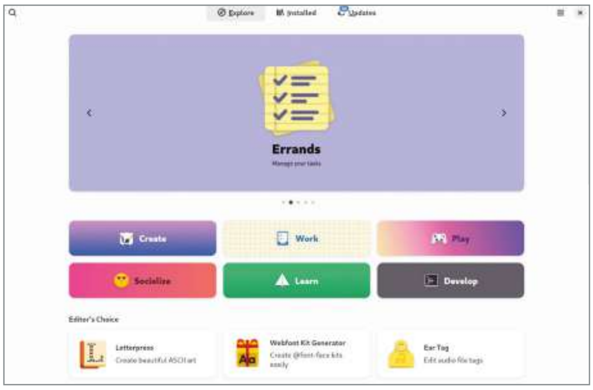
PC PRO RECOMMENDED

There's much to like about Fedora. It has heavyweight backing, a significant user base, and a long heritage

LibreOffice Writer, Calc and Impress are installed by default, so you'll be productive from day one. The default browser is Firefox but there's no pre-installed email client (as there hasn't been for several years). There are several utilities, including a document scanner, maps, the Rhythmbox media player and Boxes virtualisation environment; anything else you need is easily installed from the graphical Software app or at the terminal prompt. The Fedora software repository is enabled by default, alongside Flathub. There were 31 system and software updates waiting for download when we first logged on.

Since 2015, the default package manager, which you'll encounter if you install at the command line, has been DNF (Dandified YUM). This works in much the same way as APT (Advanced Package Tool) on Debian-based systems. While their commands may differ, their functions are analogous, and there's no reason to select one distribution or another on this basis.

There's much to like about Fedora. It has heavyweight backing, a significant user base and a long heritage. It's regularly updated and well supported, and its strong link to Red Hat Enterprise Linux makes it an excellent choice for home users who also use Linux in the workplace. Although it came behind the other distributions in the Geekbench tests, you would never guess that when using it, which is why we're putting very little weight on the raw speed data in our overall judgement.



BELOW Anything else you need can be downloaded from the installer

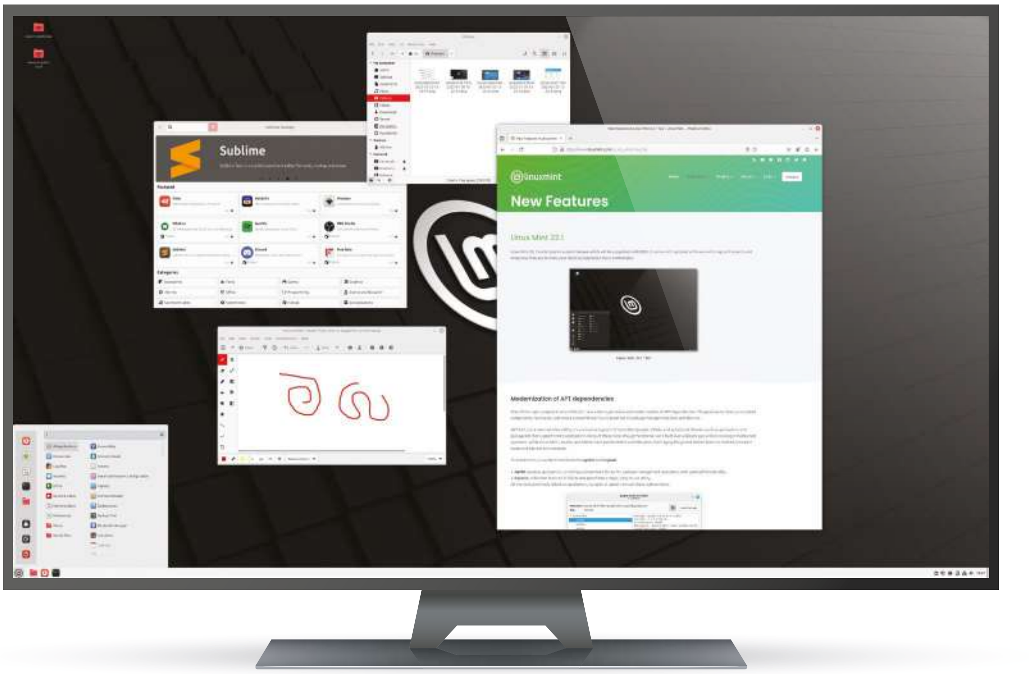
LINUX MINT 22.1

This is a popular choice for Windows switchers for good reason, but don't ignore the alternatives

SCORE ★★★★☆

WEBSITE linuxmint.com

NOT STATED **CPU** | **4GB** **MEMORY** | **100GB** **DISK SPACE**



ABOVE **With a taskbar and categorised app menu, Linux Mint will feel familiar to Windows switchers**

Linux Mint is one of the most talked-about distributions, for reasons we'll come to later. Ubuntu-based, it's been around for 18 years and has earned itself a loyal following. It's updated roughly one month after the Ubuntu LTS build on which each version is based, so you should see a major release every other year, along with point releases every six months. Major builds are supported for five years, with support for this release, codenamed Xia and based on Ubuntu 24.04 LTS, running through to 2029.

The installation process is the same as for Ubuntu: as it handles creating your user account, all you need to do once it's finished is log in. At this point you'll encounter the well-designed onboarding process, presenting a series of one-click buttons to change the system colours, open Settings, set up system snapshots and so on. The snapshots option is particularly welcome as it establishes regular periodic saves of essential system data from the outset. The process uses Cron in the background and, by default, makes a daily backup that's kept for five days.

As with the other distributions on test, we installed Linux Mint when connected to Ethernet so that it could download any additional components it required. Upon first boot, it detected our Wi-Fi hardware and we could connect directly to our wireless networks. It had spotted our networked printer without us manually loading any drivers, and the Files app exposed each of the five Samba shares running on our local network.

Mint uses its own desktop environment, called Cinnamon, which runs on X11 (Wayland is an option). Initially, there are three themes to choose from – Minty-L, Minty-X and Minty-Y – and you can opt for Mixed, Dark or Light appearances in a spectrum of colours. However, step into the advanced theme settings and you'll find a range of alternative options, including Yaru, which will be familiar from several other distributions.

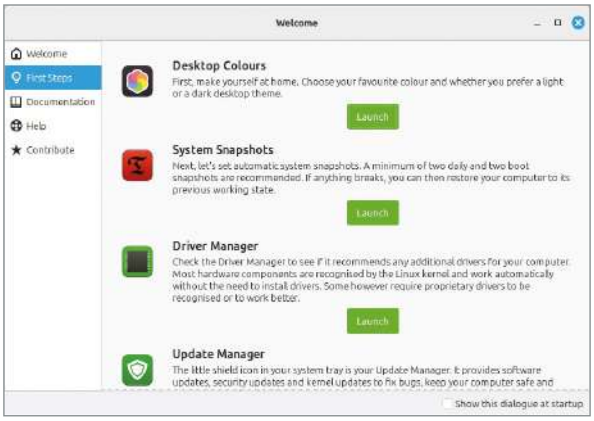
Linux Mint is often named as the ideal distribution for Windows switchers, and we can see why that's the case, with its familiar taskbar, the lack of a top menu bar and a launcher with a split listing that's highly reminiscent of the Windows Vista and 7 Start menus. Typing when the menu is visible filters matching apps on the fly: a behaviour that also manifests in KDE and Gnome environments.

However, before immediately opting for Linux Mint, we'd recommend also checking out Zorin OS (**zorin.com**). The default theme in the free edition is likewise highly Windows-esque, and if you opt for the paid Zorin Pro (£48 inc VAT), you can choose between Windows Classic, Windows 11, ChromeOS and macOS themes. We haven't reviewed Zorin OS in this Labs as it hasn't changed a lot since our last Linux Labs in issue 354, but it remains a strong choice.

PC PRO RECOMMENDED

If you want to get up and running quickly, you could do far worse than choose Linux Mint. It comes with everything you need

BELOW **You can set up system snapshots to secure your data from day one**



Desktop Colours

First, make yourself at home. Choose your favourite colour and whether you prefer a light or a dark desktop theme.

System Snapshots

Next, let's set automatic system snapshots. A minimum of two daily and two boot snapshots are recommended. If anything breaks, you can then restore your computer to its previous working state.

Driver Manager

Check the Driver Manager to see if it recommends any additional drivers for your computer. Most hardware components are recognised by the Linux kernel and work automatically without the need to install drivers. Some however require proprietary drivers to be recognised or to work better.

Update Manager

The little shield icon in your system tray is your Update Manager. It provides software updates, security updates and kernel updates to fix bugs, keep your computer safe and

☐ Show this dialogue at startup

If you don't like Cinnamon, Mint is also available with Mate and Xfce desktop environments, which you'll find if you pick "All Versions" from the Downloads drop-down menu at **linuxmint.com**.

The default install bundles a range of useful apps, including LibreOffice, Rhythmbox and Hypnotix. The last of these is a neat IPTV streaming app that gives access to free channels from 94 countries, including 108 from the UK, 17 from France and 35 from Germany. Even if you're not interested in international sports or entertainment, it's a valuable resource for language learning.

The default browser is Firefox, and Thunderbird is pre-installed to handle email. You can install anything that isn't present at launch – such as GIMP – using the bundled Software Manager or by typing at the command prompt.

If you want to get up and running quickly, you could do far worse than choose Linux Mint. It's fully featured and comes with everything you need. The fact that Hypnotix is thrown in makes it a tempting proposition for anyone who likes to keep half an eye on the telly while working. The launch menu is highly reminiscent of older versions of Windows, so this would certainly be an apt next step for anyone upgrading an outdated PC running XP or Vista, but it's not the only OS that offers this. Manjaro and MX Linux, for example, have similarly reminiscent menus, and we'd also suggest taking a look at Pop!_OS, which will handsomely repay a few minutes getting to grips with its super-fast UI.

Moving from Windows: what you need to know

Whether you're looking for an upgrade from Windows 10, a second operating system or are simply interested in Linux, here's some handy advice

Caveat emptor, the Romans said: buyer beware. The phrase may be two millennia old, but the buyer's obligation to apply due diligence before making a purchase – whether it be of a second-hand car or a new house – still applies today.

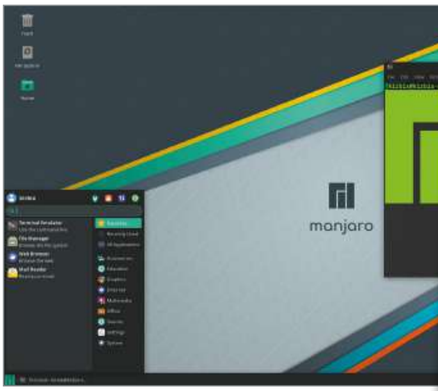
It's also true when choosing a new operating system. Whichever you settle for, you'll spend hours using it, perhaps for the next few years. You'll expect it to work flawlessly when managing your data, and probably trust it with irreplaceable personal files, such as emails and photos. It's fortunate, then, that in almost every case, you can try before you buy.

Each of the distributions on test is free to download, install and use for as long as you like. In most cases, you don't even need to go that far, as the installers themselves live within a live edition of each OS, which you can boot from a USB thumb drive and thoroughly test before committing it to your hard drive or SSD. For a longer-term test, consider installing one as a virtual machine. That way you can run it inside Windows without making any fundamental changes to your configuration.

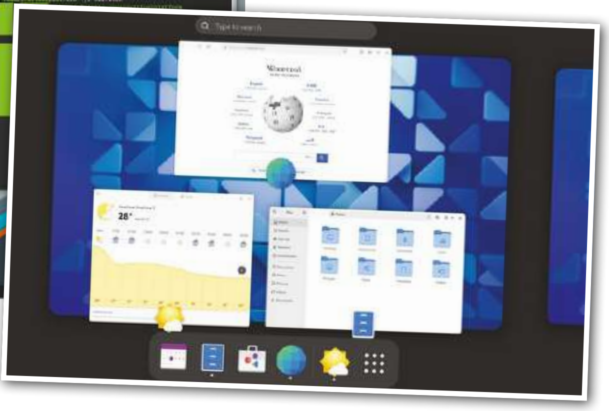
Kicking the tyres

Get a feel for the operating system. You'll probably spend most of your time interacting with the GUI, so start there. By far the most common options are Gnome and KDE, with the latter often being the most Windows-like thanks to a pop-up application menu. In Gnome, apps are more often arranged in a grid, as they are on a smartphone, or in macOS's Launchpad, unless you've added a drop-down Applications menu to the top menu bar.

But while familiarity can be comforting, we'd countenance against making it your only criteria – or even, perhaps, your primary consideration. It takes very little time to get used to a new operating system, and with KDE and Gnome both having comprehensive in-build search tools, you can quickly find an app or setting by pressing the super key (the Windows key on most keyboards) and typing a few characters. Pretty soon, you'll stop noticing either the similarity to or difference from Windows, and start navigating the UI on its own terms.



ABOVE Manjaro will be familiar to anyone switching from an old version of Windows



ABOVE RIGHT In Gnome, apps are often arranged in a grid, like on a smartphone

More fundamental differences between Windows and Linux (and less so between macOS and Linux) appear when you scratch the surface. You'll soon come to realise that many small jobs can be done more quickly using typed commands, some of which may be similar to Windows equivalents, but many of which are significantly different – not just between Windows and Linux, but between different Linux distros.

While familiarity can be comforting, we'd countenance against making it your only criteria – or even your primary consideration

Mimics need not apply

Here, then, we wouldn't recommend looking for something that mimics what you already know from another platform, but rather to consider where else you might come across Linux, and to choose a distribution from the same family. If your web host uses Debian, for example, choose something like Ubuntu or Mint. If work uses Red Hat Enterprise Linux, check out Fedora. That way, whatever you learn in one environment will apply equally to another.

debian
THE COMMUNITY
THE OPERATING SYSTEM
Download

BELOW More distros have roots in Debian than anywhere else

If you're unlikely to encounter Linux anywhere but on your own machine, this advice clearly doesn't apply, but knowing which family your distribution belongs to can still be worthwhile. More distros have roots in Debian than anywhere else, so familiarising yourself with Debian-based commands gives you the best chance of using them elsewhere in the future. The Red Hat/Fedora group comes second and Arch a close third.

The support question

Finally, consider security and support. Linux is pretty robust against malware, but you still want to be running an updated and fully patched operating system. So, check how active the developer community is, how often the distribution is patched, when cutting-edge or long-term builds are released, and for how long each receives support.

Naturally, this final consideration – support – will also be influenced by the environment in which you're installing and using Linux. If you're a home user, much of your ongoing support will be self-guided and involve reading manuals, tinkering, and turning to forums.

That's not always acceptable in a business context. There, consider how you can ensure continuity of service in business-critical systems, even if this means contracting the job to a third-party. If you take this route, be guided by them in your choice of distribution. After all, you want to know that they understand the system inside out.

MANJARO

Rolling updates mean it will stay current, but while a solid choice for Windows escapees it needs tweaking

SCORE ★★★☆☆

WEBSITE **manjaro.org**

DUAL CORE
CPU

4GB
MEMORY

30GB
DISK SPACE

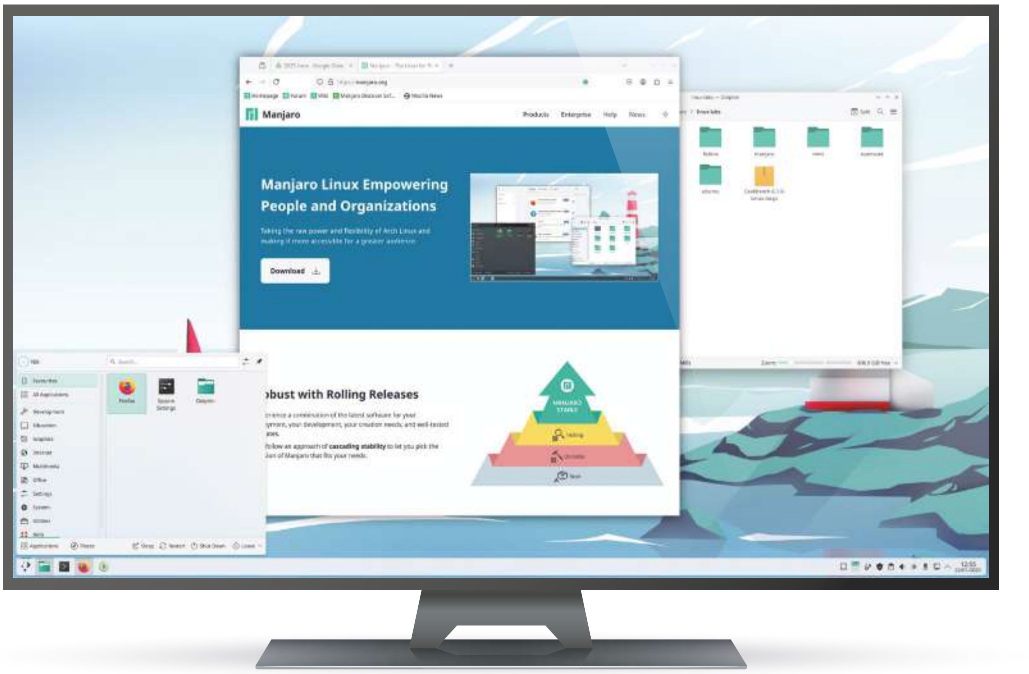
Manjaro is the only Arch-based distro on test. Along with the Arm variant, for phones, there's the x86 variant – and naturally that's the one we tested. The distro is available with a choice of desktops: KDE Plasma, Xfce and Gnome as official images, supplemented by community images featuring Cinnamon (as seen in Linux Mint), i3 and Sway WM. We opted for KDE Plasma as it was presented first in the list of official images. Our build, available in Minimal and Full flavours, was released on 16 December last year.

Manjaro uses a rolling release model in which the core is continually upgraded as replacement builds become available. That means you shouldn't need to do a large manual update at any point. As such, there's not really a version number, and if you enter "cat /etc/os-release" at the terminal, you'll see that BUILD_ID = rolling. Technically, therefore, so long as you keep applying patches when they're released, you'll never reach the end of your operating system's support window.

As with KDE in openSUSE and Cinnamon in Linux Mint, this distro should be familiar to anyone switching from an older version of Windows, thanks to a screen-wide taskbar and categorised app menu. Open the menu and start typing, and the list of matching apps and options is streamlined in real-time. Helpfully, the results include settings as well as software, so if you're looking to change your resolution you only need to get as far as "reso" for Display Configuration to be the top hit. This makes navigating the operating system extremely easy, which should soften the landing for less experienced users.

By default, KDE on Manjaro runs on the X11 windowing system, but you can switch to Wayland from the login screen (and switch back and forth like this as often as you require). As was the case with KDE on openSUSE, we found the Wayland implementation to be brighter and bolder at its default settings, but you can tweak X11 for similar results.

Setup is simple. It's managed by the Calamares installer, which walks you through the process of choosing your language, location and so on, and also lets you choose between two office suites or no office suite at all. Your options are LibreOffice, as seen in most other suites, and SoftMaker FreeOffice. Like LibreOffice, FreeOffice is also available for Windows and it can read and edit Microsoft Office files. It's a good-looking suite with a colourful ribbon interface, but to access high-quality dictionaries for spellchecking, table styles, footnotes and endnotes, picture captions and several other features, you'll need to upgrade to the charged-for SoftMaker Office.



ABOVE **The default interface should pose no problems for Windows switchers**

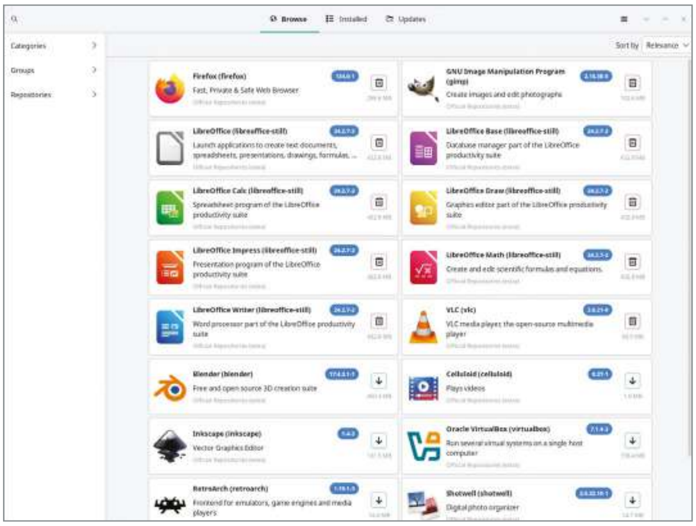
You can see the full comparison table at **tinyurl.com/367softmaker**.

Elsewhere, you'll find a healthy selection of utilities, including the Elisa music player and VLC. GIMP and Inkscape, while available through the bundled app store, weren't installed by default, but this isn't unusual. The pre-installed web browser is Firefox, but there's no email client. Kmail, Thunderbird and other options are again available through the installer.

Technically, so long as you apply patches when they're released, you'll never reach the end of your operating system's support window

There were eight packages ready for an update on first boot, once our wireless networking hardware had been detected and set up. As with openSUSE, our networked printer and the five Samba shares on our local network weren't immediately accessible, although when we manually added our printer using its IP address, the correct manufacturer was detected. We could also access our Samba shares using their IP addresses, but using local hostnames failed in our default configuration.

Manjaro with KDE Plasma is attractive, and if you're looking for a familiar non-Microsoft upgrade path from an older version of Windows, this would be one to shortlist alongside Mint, openSUSE and Elementary OS – or, indeed, any KDE-based distro. Although we encountered a few niggles on our test platform, they're the kind of things that, once overcome, won't be an ongoing issue.



BELOW **The integrated installer is stacked with all the software you're likely to need**

MX LINUX 23.5

This lightweight distro is a great choice for squeezing life out of older PCs, but it's not the slickest option

SCORE ★★★★☆

WEBSITE mxlinux.org

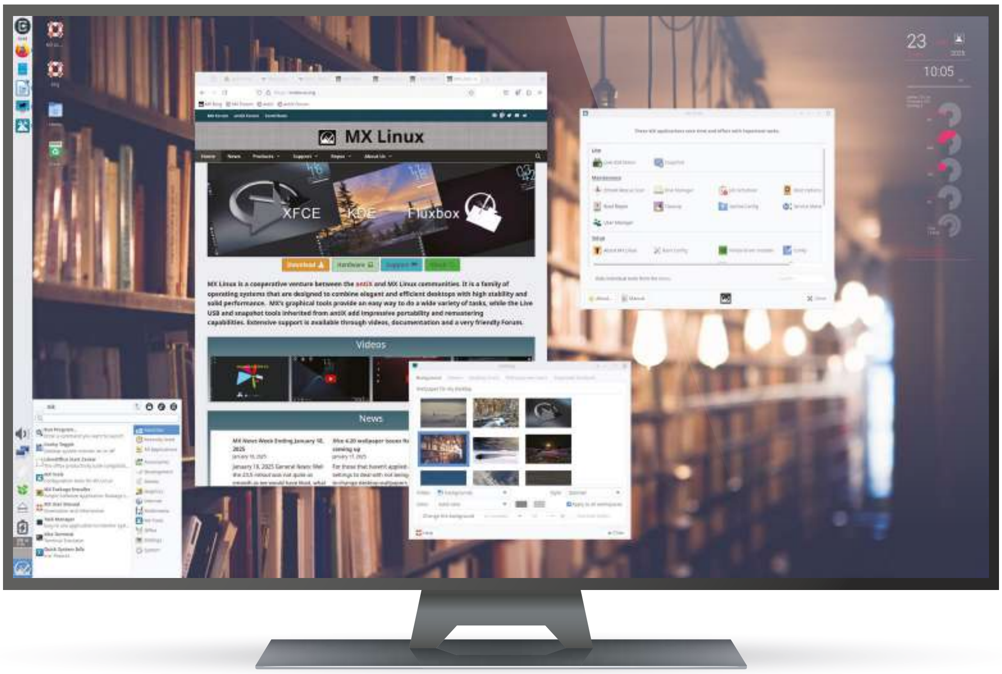
i686 OR LATER CPU
2GB MEMORY
20GB DISK SPACE

This is the only distribution on test running the Xfce desktop environment by default. Designed to run well on less powerful hardware, this makes MX Linux a natural choice for anyone who wants to squeeze a few more years of life out of an ageing machine. If you don't get on with Xfce, it's also available with KDE and Fluxbox, but there's no harm in giving it a go: you can install alternatives later, including Mate, Gnome Base and Budgie, from the Package Installer.

In its default state, this particular implementation of Xfce looks more basic (and to our eyes less appealing) than KDE or Gnome, but it's highly customisable and you can add themes, so there's no reason for it to stay like that. For example, the panel, which runs up the left border and gives quick access to your preferred apps, was small on our 32in display, but right-clicking it gave us direct access to its settings. Here, we adjusted the row size to a more comfortable 60 pixels and changed the colour, but you can add and remove items, and more besides.

We went on to entirely swap out mx-comfort, which is the distro's default theme, opting for Arc for applications and the Window manager, and Adwaita for icons and cursors. This was a quick and easy fix that brightened things up enormously and created a far more appealing environment in which to do our work.

Whatever change you want to make, anywhere in the system, you should have little trouble finding the dialog to implement it: simply press the Windows (or, on Macs, the symbol) key and start typing the first few characters of the most logical shortcut. For example, if you need to change the overall resolution, type "di" or "resol" (for display or resolution) and before you go any further, the Display settings will be pre-selected. This kind of navigation, which we've highlighted elsewhere, is a boon for new users who are finding their feet in unfamiliar territory.



MX Linux is a cooperative venture between the antiX and MX Linux communities. It is a family of operating systems that are designed to combine elegant and efficient desktops with high stability and solid performance. MX's graphical tools provide an easy way to do a wide variety of tasks, while the Live USB and snapshot tools inherited from antiX add impressive portability and remastering capabilities. Extensive support is available through videos, documentation and a very friendly Forum.

ABOVE This is the only distro on test in which Xfce is the default desktop environment

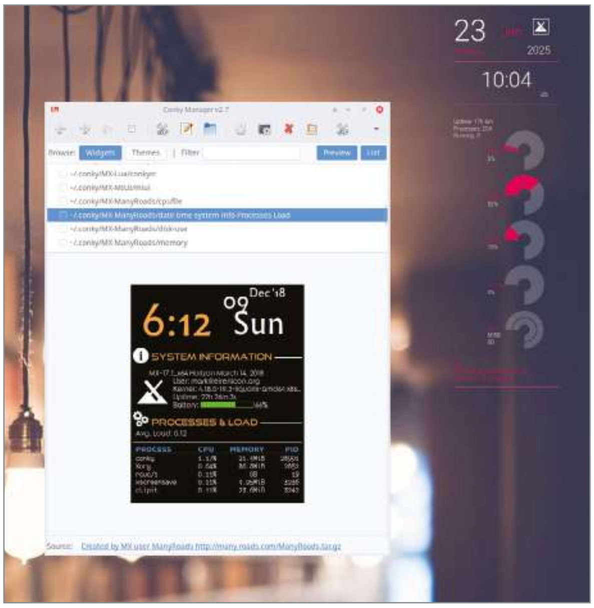
Those same users may likewise welcome the traditional categorised applications menu, which will be familiar to anyone switching from older versions of Windows.

On first boot, MX Linux detected our wireless hardware and we could see our Wi-Fi networks. Our networked printer had also been spotted without us installing any third-party drivers, and when browsing the network through Thunar, the file manager, we could see our Samba shares.

Firefox, Thunderbird and VLC come pre-installed, along with a range of media players, utilities and a handful of brain-improving games – but no GIMP or Inkscape. These, along with hundreds of other apps, are available through the Package Installer, which may lack the visual appeal of app stores seen elsewhere but is searchable and logically categorised.

Conky, which is an optional add-on for other distributions, is also pre-installed. If you like to keep an eye on your resources and how they're being used, you'll love it, as its integrated widgets let you display a wide range of live data directly on the desktop. Or you could just use it to show a pretty clock.

MX Linux is a highly configurable and fun distribution, with extremely conservative system requirements



Source: Created by MX user ManyRoads http://many.roads.com/ManyRoads.tar.gz

BELOW Dip into Conky and you can display all sorts of interesting data on the desktop

Overall, MX Linux is a highly configurable and fun distribution, with extremely conservative system requirements. Version 23.5, on test here, will run on an i686 Intel or AMD processor with 1GB of memory and 6GB of storage. That's impressive, and even the "recommended" specs are far from demanding, stretching to 2GB of RAM and 20GB of drive space. As it will run on 32-bit hardware, there's no excuse to throw out an old machine when you could repurpose it for background tasks, network storage or even daily use. This build is supported until June 2028.

Perhaps unsurprisingly, given these requirements, it was the fastest distribution by a comfortable margin on our test machine. In single-core and multicore runs in Geekbench, it beat the slowest distribution by 11% and 28% respectively. However, as we noted in our Fedora review, each of the distributions on test felt slick in general use, so we're not putting much weight on raw performance in our scores.

→

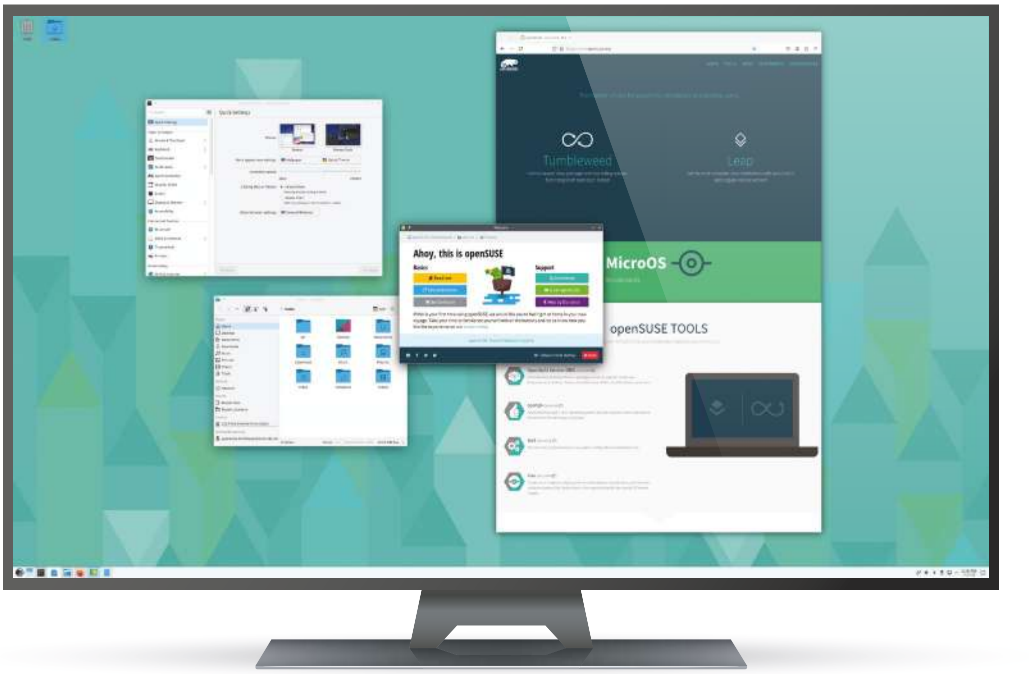
OPENSUSE TUMBLEWEED 20250120

Windows 10 EOLers should definitely give Tumbleweed a try, with a familiar interface and constant updates

SCORE ★★★★☆

WEBSITE get.opensuse.org

2GHz DUAL CORE CPU | **2GB** MEMORY | **40GB** DISK SPACE



Now 30 years old, openSUSE is one of the longest-standing distributions still in widespread use. Despite this, it will almost certainly be the most up-to-date option whenever you choose to install it. That's because Tumbleweed is in continuous development, with a new release shipped every day. Indeed, look at the official title of this review and you can work out when we downloaded it (naturally, there were no patches available for installation upon first boot).

If you don't like the idea of an ever-changing distribution, opt instead for openSUSE Leap. This is a more traditional model with major updates appearing annually and an emphasis on stability rather than including the most cutting-edge components. You'll need to invoke it manually to upgrade a Leap installation, but with Tumbleweed the process is more frequent, with updates appearing as soon as they've been integrated and tested by the openSUSE community. As such, there isn't a traditional support period for Tumbleweed releases the way there is for a conventional operating system.

The installer presented no surprises. Everything was well explained and logical, and it handled user account creation as part of the process. On our PC's restart, it had detected our wireless hardware, but not our networked printer. The five SMB servers on our local network didn't appear in the Dolphin file browser, either. It turned out that access to both the servers and the printer were being blocked by the firewall. Fortunately, there was an easy fix: using the integrated Firewall configuration tool to add the necessary services to the Allow list.

The preferred user interface is KDE Plasma 6 (which we're using here), although the installer also gives you the choice of Gnome, Xfce and IceWM. Elsewhere, you'll find downloads for Cinnamon (as used by Linux Mint), Mate, Pantheon (as used by Elementary OS) and others.

The first time we logged in, it used the X11 window manager, which many distributions are swapping out in favour of Wayland. You can switch to Wayland on the login screen, and when we did this we found that the UI was both brighter and much larger, as the zoom had been reset to 150%, which we found more comfortable for ongoing use. You can naturally change this to whatever you prefer in both Wayland and X11.

Windows switchers are frequently encouraged to opt for Linux Mint if moving to open source, but we'd argue that openSUSE is just as easy to get to grips with, thanks to the familiar taskbar and a categorised application menu. Open the menu and start typing the name of the app or feature you're after, and the list of results will be filtered on the fly. The fact that the results include settings makes finding your way around Tumbleweed easy.

ABOVE The default desktop environment in openSUSE is KDE Plasma 6

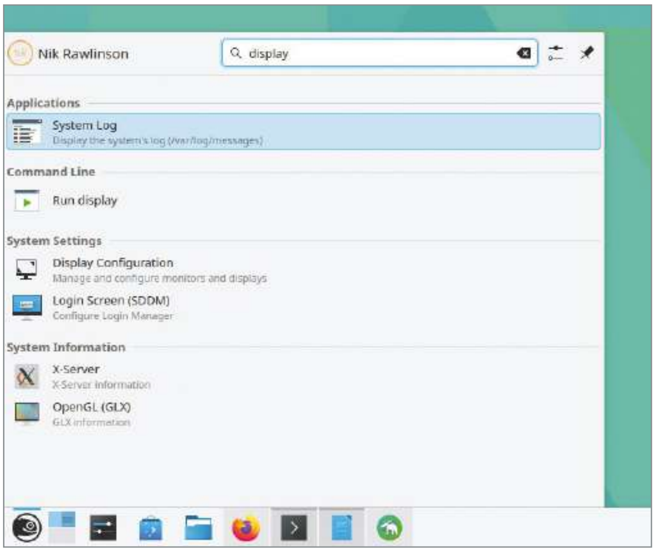
> **There are plenty of reasons to recommend openSUSE Tumbleweed, and really only one thing that counts against it**

Our installation featured a full range of familiar applications, including Firefox for browsing, Kmail for comms and LibreOffice. Neither GIMP nor Inkscape were preinstalled, but they're available through the Discover installer, which provides access to repositories such as Flathub, Flatpak, openSUSE and KDE Store. Elsewhere, there's a generous selection of utilities, a handful of brain-improving games and VLC, which cover everything you need to get started.

If you pride yourself on running the latest possible build of your operating system, then look this way. The same goes if you want the option to switch between X11 and Wayland, and an almost unbeatable range of desktop environments. Windows switchers – and particularly those moving up from an older release with a more traditional start menu – would likewise do well to consider this alongside Linux Mint.

So, there are plenty of reasons to recommend openSUSE Tumbleweed, and really only one thing that counts against it: the additional tinkering we had to do post-install to get it working the way we wanted. Fortunately, that's the kind of thing you should need to fix only once.

BELOW If you're looking for a setting or an app, just open the menu and start typing



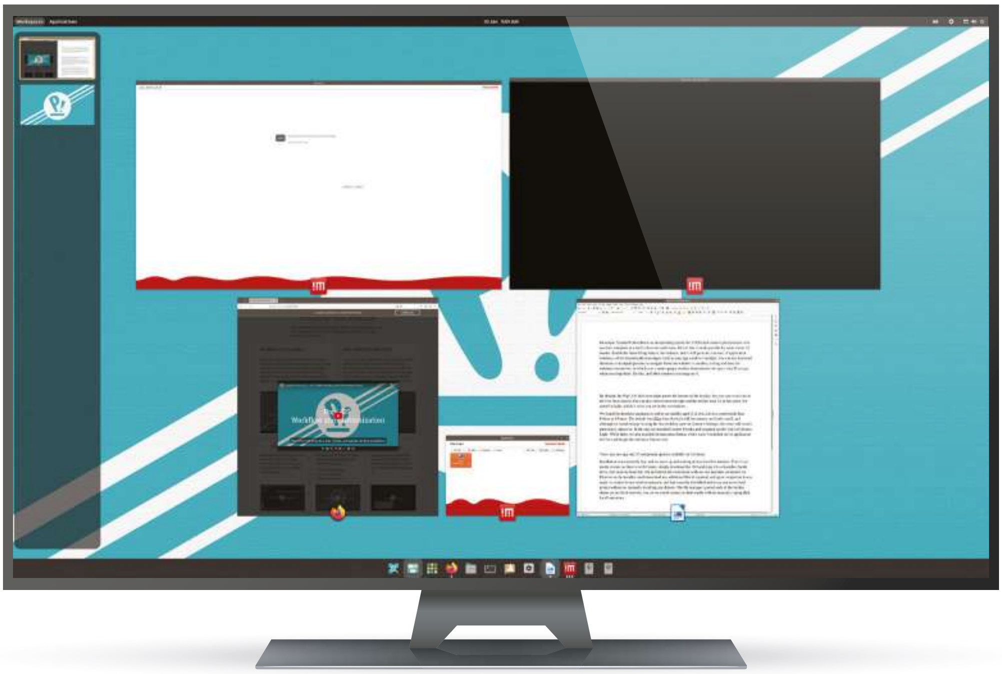
POP!_OS

A great choice for advanced users who love keyboard shortcuts and it runs quickly on older PCs too

SCORE ★★★★☆

WEBSITE pop.system76.com

64-BIT CPU **4GB** MEMORY **16GB** DISK SPACE



ABOVE Neat innovations help you navigate and arrange your windows quickly

Developer System76 describes Pop!_OS as an operating system for STEM and creative professionals who use their computer as a tool to discover and create. In part, this is made possible by some clever UI tweaks that help you navigate the interface more quickly. Enable the Auto-Tiling feature, for instance, and it will generate a mosaic of application windows, which dynamically rearranges as your windows multiply. You can use keyboard shortcuts or trackpad gestures to navigate from one window to another, or drag and drop the windows themselves – in which case a semi-opaque overlay demonstrates the space they'll occupy when you release them. When you do this, other windows rearrange to fit.

The way you find and launch apps has been rethought, too. Press the Windows/symbol key and, rather than shrinking the workspace to show a grid of apps, it opens the Pop!_OS launcher. This doesn't feature a grid of apps, as you may have encountered elsewhere, nor a two-column menu as you might see in KDE- or Cinnamon-based distros. Instead, applications have been organised by type-based folders, with categories for Office, System and Utilities. You can add your own categories as you install further apps. Type the first few letters of the app you want to use and the list is filtered in real-time until you find what you need. It's extremely responsive, with no lag at all on our almost six-year-old test machine. Indeed, we were impressed by the speed at which Pop!_OS performed throughout our tests and would have no hesitation in using it to extend the working life of an old device.

The only thing that might initially discourage us is the default interface, which, to our 50-something eyes, is less comfortable and attractive than Fedora or Ubuntu. The default font (Fira Sans Book) is tall but narrow and fairly small, and although we could enlarge it using the Accessibility pane in Gnome's Settings, we eventually installed Gnome Tweaks and swapped out the font for Ubuntu Light. While there, we also enabled the maximise button, which, unlike the minimise button, wasn't switched on for application title bars.

By default, the Pop!_OS panel (or taskbar) runs right across the bottom of the display, but you can tweak that in the first-boot wizard. You can also choose between light and the default dark UI at this point. We opted for light, which is what you see in the screenshots.

Installation was extremely fast, and we were up and running in less than five minutes. There's no media creator as there is with Fedora: simply download the ISO and write it to a bootable thumb drive, then start up from this. We performed the installation with our test machine connected via Ethernet so the installer could download any additional files it required.

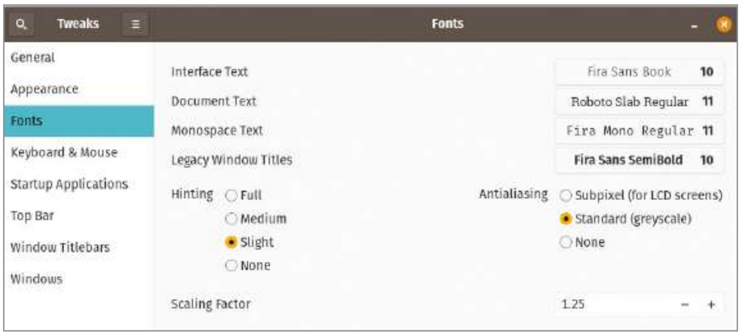
Upon completion it was ready to connect to our wireless network and had correctly identified our networked printer without us manually installing any drivers. The file manager spotted each of the Samba shares on our local network, too, so we could connect to them easily without manually typing their local hostnames. Firefox is the default browser, while Geary sits ready to handle email. There was one app and 37 component updates ready to download upon first boot.

It's extremely fast – you feel like you're flying from one task to another – and we were quickly won over by the re-thought launcher

Pop!_OS is Ubuntu-based, with this release drawing code on the 22.04 LTS build (released in April 2022, and supported until April 2027). At present it runs Gnome 42 on X11, although System76 is working on Cosmic, a new desktop environment that looks set to roll the best of Pop!_OS's workflow management tools into a full-on Gnome replacement. To find out more, visit **system76.com/cosmic**.

Although we initially found Pop!_OS a little unattractive, we quickly grew to enjoy it, and anyone who writes it off too soon will be doing themselves a disservice: if you don't get on with the look and feel, tweak them. Anecdotally, it's extremely fast – you really do feel like you're flying from one task to another – and we were quickly won over by the re-thought launcher. It kept our ageing machine feeling sprightly, and on that basis alone the time it takes you to set it up could be the most profitable few minutes you spend today.

➔



Interface Text: Fira Sans Book 10
Document Text: Roboto Slab Regular 11
Monospace Text: Fira Mono Regular 11
Legacy Window Titles: Fira Sans SemiBold 10
Hinting: ○ Full ○ Medium ● Slight ○ None
Antialiasing: ○ Subpixel (for LCD screens) ● Standard (greyscale) ○ None
Scaling Factor: 1.25 − +

BELOW We made a few changes to the default appearance using Gnome Tweaks

UBUNTU 24.10

Like Fedora, a fine choice for Windows switchers and everyone else thanks to great support and features

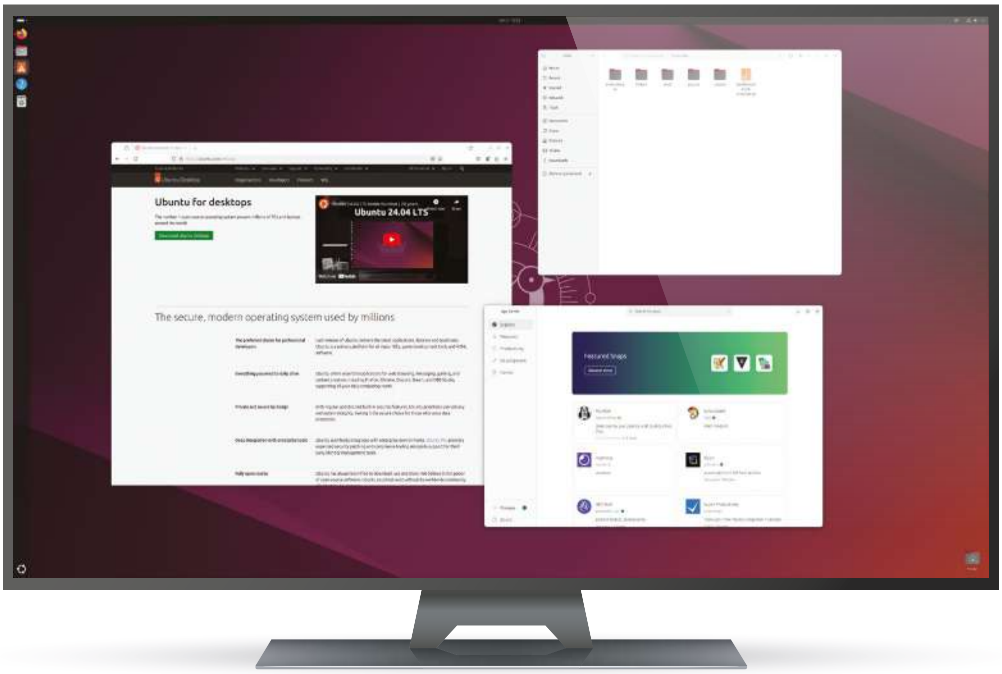
SCORE ★★★★★

WEBSITE ubuntu.com

2GHz DUAL CORE
CPU

4GB
MEMORY

25GB
DISK SPACE


Ubuntu for desktops

Ubuntu 24.04 LTS

The secure, modern operating system used by millions

ABOVE **The full-height panel on the left of the screen is a distinctive Ubuntu feature**

Ubuntu is possibly the best-known desktop distribution among consumers – and with good reason. Not only is it fully featured and frequently updated, it's also the basis of many other distros, including Zorin OS, Elementary OS, Pop!_OS and Linux Mint. That might surprise you when you consider how different they each look, but it's like Android phone manufacturers putting their own skin and refinements on Google's stock OS. As a result, Ubuntu is well supported and has a large user base, which can help when searching for answers.

You can choose between minimal and full installations, with the former featuring just a narrow selection of software, including Firefox but no email client or office suite. The full build rolls in LibreOffice, Rhythmbox media player, Shotwell photo organiser, Thunderbird and Gnome Calendar. Other essentials, such as GIMP, Inkscape and Scribus, are available for download through the App Centre or at the command prompt on either installation.

Ubuntu releases major updates every six months, with the version number indicating the year and month in which each one first appeared. Ubuntu 24.10, which we're reviewing here, was posted for download on 10 October 2024 and will receive support through to July 2025. Every fourth release is designated a Long Term Support (or LTS) build, which is supported for five years. Of these, the most recent is 24.04, for which support will extend through to April 2029. Many third-party distributions are based on LTS builds.

If you opt for Ubuntu LTS, we'd highly recommend signing up for Ubuntu Livepatch as part of Ubuntu Pro, which is free for personal use on up to five computers. It enables live patching of the kernel without the need to reboot, so you remain secure while reducing interruptions. It also extends the ongoing support window to ten years. With Ubuntu Pro, 24.04 LTS is supported until April 2034, and legacy support continues to April 2036 (although by this point you will surely have upgraded to enjoy whatever innovations future releases deliver).

Ubuntu 24.10 is based on the 6.11 Linux Kernel and runs version 47 of the Gnome desktop environment, with Wayland handling screen output. These are all bleeding-edge releases, and Wayland in particular is seen by many to offer security and efficiency benefits over X11, which it looks likely to ultimately replace.

New users should have no trouble getting up and running. The installation wizard is well explained, makes some sensible assumptions, and lets you set your accessibility options (for sight, hearing, mobility and other issues) on the second dialog. Naturally, you can make the same changes inside the OS itself.

As we opted for a minimal installation in our tests, there were only two updates ready for download on first boot. Our wireless hardware had been detected – we used Ethernet during installation – and it had spotted our network printer without us manually installing any drivers.

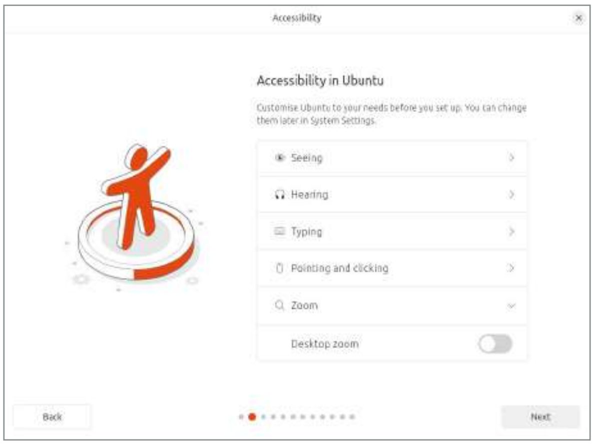
The default look and feel is clean and uncluttered, and application windows have a full complement of minimise, maximise and close buttons (which is only worth mentioning as you can't take this for granted with other distributions). The Dock runs up the left edge of the screen by default, but you can move it to the right or bottom, and set it to float or auto-hide.

There are default and dark themes in a range of colours, and the standard font – Ubuntu Sans – is easy to read, although we do prefer Cantarell, as used by Gnome in Fedora. Naturally, you can change resolution and scale directly, but if you want to make any significant changes, such as picking a different system font, you'll need to install Gnome Tweaks (free from the App Centre).

There's no denying that Gnome, which Ubuntu uses by default, looks significantly different to Windows, but here it includes Ubuntu Dock – a bespoke component that's reminiscent of the taskbar seen in both Windows and other distros. System settings are clearly explained and easily navigated, and everything is set up from first boot, with an onboarding process that doesn't require much more than a handful of clicks. If you have the headspace to switch back and forth between a desktop and mobile operating system, getting to grips with Ubuntu shouldn't be a challenge.

PC PRO LABS WINNER

> **The installation wizard is well explained, makes some sensible assumptions, and lets you set your accessibility options**


Accessibility in Ubuntu

Customise Ubuntu to your needs before you set up. You can change them later in System Settings.

BELOW **Accessibility options appear early as part of the Ubuntu onboarding process**

View from the Labs

Five years into his Linux switch, Nik Rawlinson explains why he will never go back – and why he thinks *PC Pro* readers should follow his lead

So long, Windows 10. As mentioned at the outset, Microsoft will end support from its decade-old operating system later this year. So, if you haven't already upgraded to Windows 11, now would be a good time to consider your next step. Sticking with Windows is one option but, as our reviews hopefully show, switching to Linux is a viable alternative.

The last time I wrote a Linux Labs, I said the platform had come of age: nothing that's happened since then has changed my mind. Together, the various distributions cater for just about any requirement, whether that's photo editing on a high-end workstation or breathing new life into a decades-old machine that would otherwise head for recycling.

In devising this Labs, I took the centre ground. My test machine was a Dell OptiPlex 3060 from 2018, which was running Windows 10 when I picked it up, second hand, for a bargain £120. With a Core i5-8500T processor, 8GB of memory and a 256GB SSD, its specs are rather conservative when compared to more modern hardware, but I consider it typical of the kind of a machine that a Windows switcher might consider upgrading to Linux – perhaps while buying a faster, smarter machine for Windows 11 if they choose to head in that direction.

Nik Rawlinson is a former editor of *MacUser* but switched to Linux in 2020

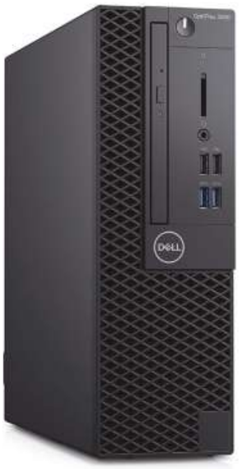
As you'll see from our tests, each of the distros was more than capable of getting the best from my vintage PC. They ran smoothly and swiftly, and most were ready to use from first boot. Even those that weren't needed just a few tweaks to sort out.

In fact, these distributions did so well, and proved once and for all that Linux is no longer an operating system solely for the technically minded, that in some cases I was forced to hunt for anything negative to say.

"With every release, these Linux distributions become more capable and, for the most part, more attractive and easier to use"

Linux isn't only a way of keeping old PCs running longer, though – nor of avoiding the upgrade to an operating system with AI smarts. Rather, it's a true alternative to the "mainstream". I've been using Linux on my primary desktop for the past five years, day in, day out, and while I use Windows for testing and macOS for graphics work, I have no plans to return to either of them full time for regular office work.

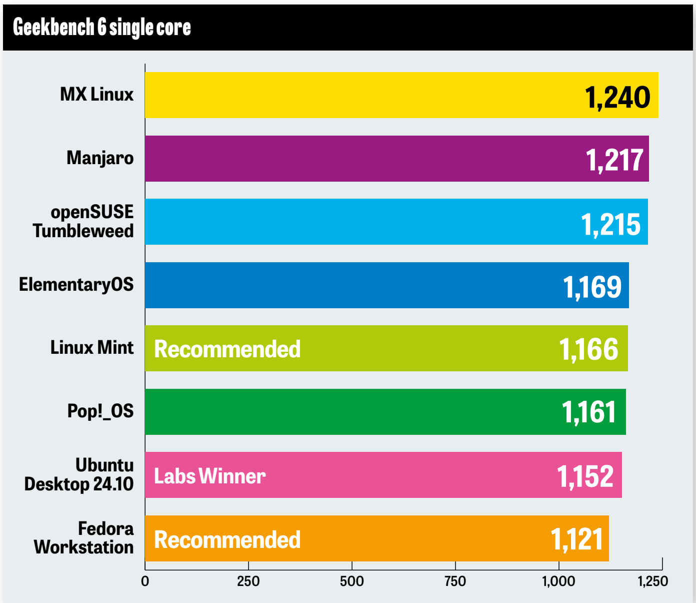
With every release, these Linux distributions become more capable and, for the most part, more attractive and easier to use. KDE and Gnome both look sharp and fresh, and their adoption by multiple distributions means you're not tied to a single provider: you can chop and change distro as often as you like but use the same UI wherever you end up. Better yet, many distributions now benefit from platform-agnostic package installers such as Flatpak, which make it all but certain you'll be able to run whichever app you need, whichever distribution you happen to be using. Using a tool such as Flatpak also saves you the chore of learning different commands for different distros when installing at the console.

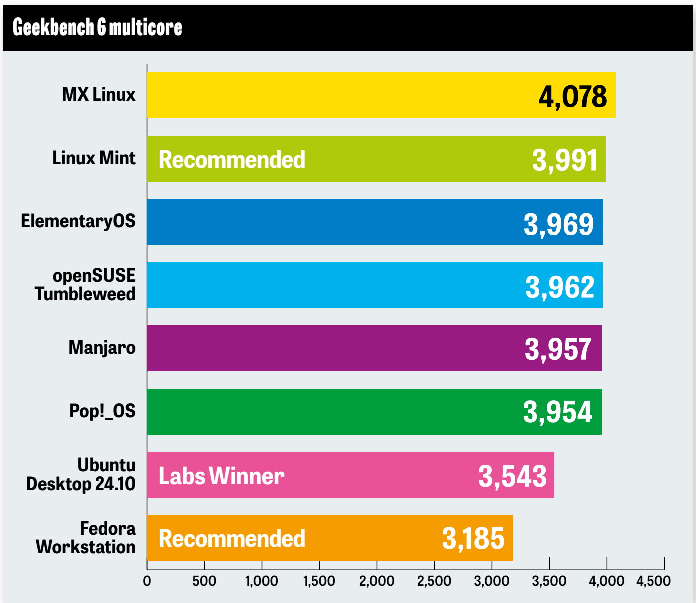


LEFT All the distros in this Labs ran well on a second-hand Dell PC

If you haven't tried Linux yet, I urge you to give it a go. Either buy a cheap second-hand machine, as I did, use a host utility like VirtualBox to run it inside Windows or macOS, or set up your main machine to dual boot (but back up everything first). And, if you briefly encountered Linux many years ago but it didn't work out, now would be a great time to get yourself reacquainted. You may find that whatever put you off last time around has been solved or obsoleted. ●

Test results





Test rig: Dell OptiPlex with Core i5-8500T and 8GB RAM

The Network

Practical buying and strategic advice for IT managers and decision makers

Best business cloud file-sharing services

If you want to share files seamlessly and securely across your business, a dedicated service is ideal. We review four of the strongest contenders

As workforces become more mobile, businesses may find traditional file-sharing using on-premises servers holding them back. Cloud file-sharing is the ideal alternative as these services offer secure and convenient ways for remote workers to collaborate with colleagues and clients regardless of their location.

Cloud services require no upfront investment in hardware or maintenance contracts and all reputable providers implement best security practices to ensure your data is safe. There's no need to connect remote workers to the main office over complex virtual private networks (VPNs) either, as cloud services are designed to allow users to seamlessly access work documents in the cloud anytime, from anywhere and from their choice of device.

An unprecedented demand has presented SMBs with a huge choice of affordable cloud file-sharing services. This month, we review business-focused cloud services from Dropbox, Egnyte, Progress and Tresorit, and conduct hands-on testing in the lab to help you make the right choice.

Making plans

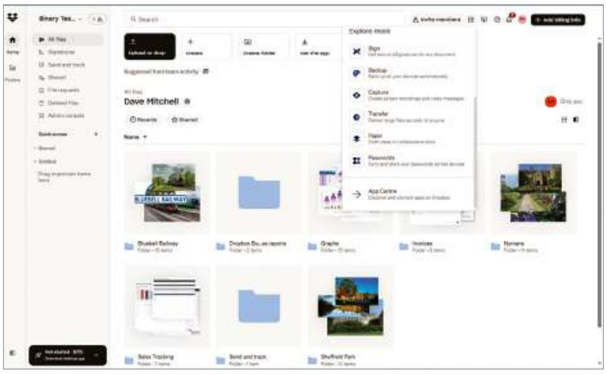
Avoid free, consumer-friendly cloud services as these are aimed at personal use and have significant capacity restrictions on cloud storage, along with strict limits on the size of files you can upload and share. Business plans offer much more generous cloud storage capacities and provide an administration web portal for managing your company's cloud account and deciding who can access it, a feature not available in free plans.

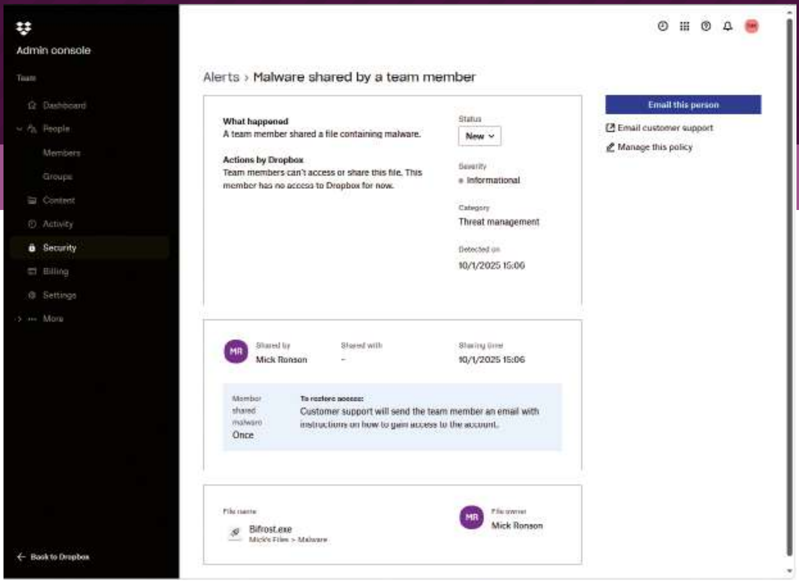
Prices are generally based on the number of users, with many plans starting with a minimum of three users. SMBs should look first at providers offering complete price transparency on their website so they can accurately gauge their ongoing costs without having to deal with sales reps and tedious quote negotiations.

Plans are available in a variety of tiers, with the best providers showing detailed feature comparison lists on their websites so you can see precisely what is, and isn't, included. Check if plans can be upgraded or downgraded later on as your requirements will invariably change over time.

Along with different amounts of cloud storage per user, each tier has restrictions on the maximum allowable file size that can be uploaded. Most business plans start at around 15GB, which will be enough for smaller businesses, but those handling very large files such as medical images or CAD drawings will want a much higher limit; one vendor in our guide supports 250GB file sizes.

BELOW The Dropbox web portal provides easy access to all cloud files and apps





Alerts › Malware shared by a team member

What happened
A team member shared a file containing malware.

Actions by Dropbox
Team members can't access or share this file. This member has no access to Dropbox for now.

Status: New
Severity: Informational
Category: Threat management
Detected on: 10/1/2025 15:06

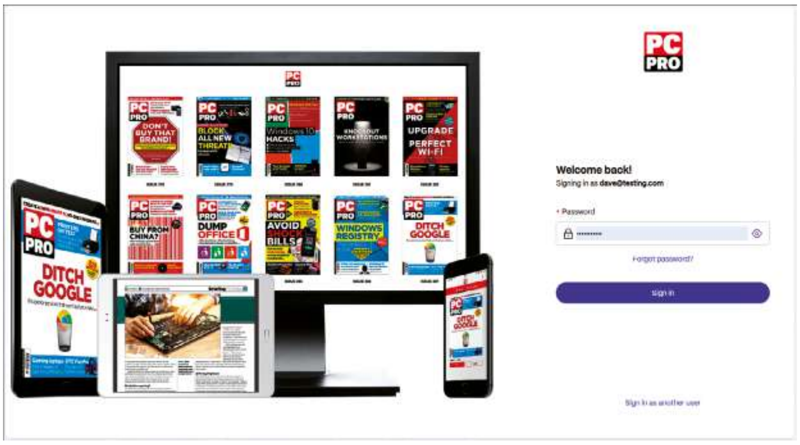
Shared by: Mick Ronson
Shared with: –
Sharing time: 10/1/2025 15:06

Member shared malware: Once

To restore access:
Customer support will send the team member an email with instructions on how to gain access to the account.

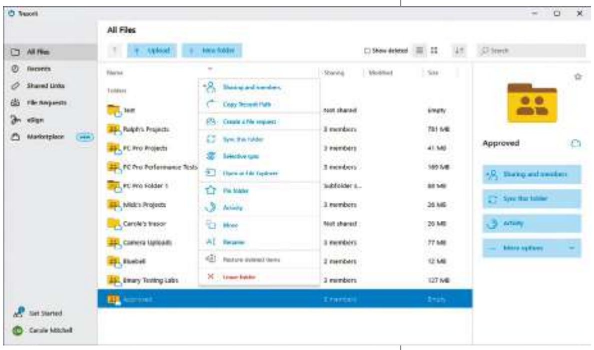
File name: Bifrost.exe
Mick's Files > Malware
File owner: Mick Ronson

LEFT **Dropbox Business scans files for malware when a user tries to share them**



Welcome back!
Signing in as dave@testing.com
• Password

LEFT **ShareFile offers outstanding portal branding features for that extra touch of professionalism**



ABOVE **Tresorit's app provides users with easy access to all their cloud files**

Safety net

Data-protection regulations demand that data is kept secure, and the minimum requirement you should expect from your provider is AES-256 encryption of data prior to transmission and at rest in their cloud data centres. Businesses handling confidential documents and those containing personally identifiable information (PII) should consider providers that encrypt shared data on the user's devices and offer zero-knowledge encryption so only you have access to the keys. One product in the guide implements this as standard, while another offers it as an optional feature.

Cloud account access controls are just as important, with the best providers allowing you to apply policies that force users to create strong account passwords that adhere to a minimum format and length. To add extra security, consider services that offer two-factor authentication (2FA) and those that work with single sign-on (SSO) providers.

Some providers include malware protection and will automatically scan files as they're uploaded to the cloud or shared, and will quarantine any files with dubious content. Other security features to look out for are detection of suspicious behaviour such as multiple failed login attempts and classification of documents containing sensitive information.

Agents of change

An administrative web portal allows managers to send email invitations to users and, after signing up, they provide a new password and receive a personal web portal to manage their private and shared files. They'll also be prompted to download a desktop syncing agent that creates a mapped drive, so they can directly access their cloud files and, if required, sync selected folders to a local device for offline access.

Look for granular access controls that allow admins to decide who is allowed to use the cloud storage and share, receive and send documents. A valuable feature is subfolder access permissions – you may have a general-purpose projects folder but only want selected workgroups or users to access specific parts of it.

Cloud file-sharing neatly overcomes file attachment size limitations imposed by email providers as users can securely send large files by creating a web link from their web portal and emailing that instead. The recipient clicks on the link in the message to download the file from the cloud and, for increased security, look for those that offer recipient verification, link password protection, download limits and expiry dates.

> **"Mobile support is essential as users can access shared files from their smartphone or tablet while out of the office"**

App integrations

Cloud file-sharing doesn't need to be a separate business process. Many services offer tight integration with other apps such as Microsoft 365 and Google Workspace. Some work with Microsoft Teams and allow users to share selected folders with other Teams members and upload or download files directly from their Teams apps.

Companies aiming to replace pen and paper with digital workflows for signing contracts and agreements should look for e-signature integrations. Some providers work with third-party apps such as Adobe Sign and DocuSign while others have integrated their own e-signature services, with some offering plans that include unlimited use.

Mobile support is essential as users can access shared files from their smartphone or tablet while out of the office. Features vary considerably, but the best providers offer free iOS and Android apps, with some including advanced features such as using your device's camera to scan documents and send them directly to your cloud account without storing them locally.

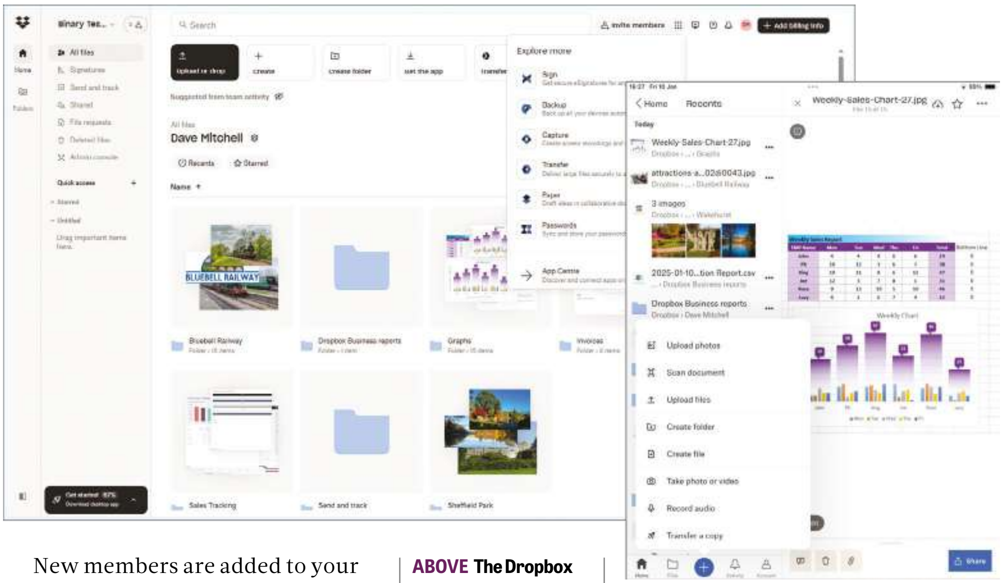
The four cloud file-sharing services in this buyer's guide were chosen because the vendors provide full details of the features included in each plan and complete price transparency. They're all also available as free time-limited trials so you can try them out first to see which one best suits your cloud collaboration plans.

Dropbox Business Plus

An incredible range of file-sharing tools for the price, with good security and support for huge file uploads

SCORE ★★★★★

PRICE £18 exc VAT per user/month billed yearly from dropbox.com


Binary Tes...
Search
Invite members
Add billing info
All files
Signatures
Send and track
Shared
File requests
Deleted files
Admin console
Quick access
Upload or drop
Create
Create folder
Get the app
Transfer
Suggested from team activity
Dave Mitchell
Recents
Starred
Name
Explore more
Sign
Backup
Capture
Transfer
Paper
Passwords
App Centre
Bluebell Railway
Dropbox Business reports
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Dropbox Business reports
Upload photos
Scan document
Upload files
Create folder
Create file
Take photo or video
Record audio
Transfer a copy
Share
Weekly Chart

ABOVE **The Dropbox web portal and mobile apps are well designed and very easy to use**

With a track record reaching back nearly 18 years, Dropbox is undeniably one of the most popular cloud file-sharing platforms. The reasons are manifold: it has always offered an impressive range of features and will appeal to SMBs that want an affordable and secure cloud collaboration platform.

Available in a wide range of plans, the top-dog Business Plus on review costs £18 per user per month when billed yearly, starts with three users and presents 15TB of shared storage, which increases by 5TB for every extra user and can also be upgraded in 1TB increments as required. A closer look at the features shows this plan to be very good value as it enables the security add-on for ransomware protection, malware scanning, suspicious behaviour detection and classification of files with PII content.

It includes tiered administration roles, audit logs, heaps of app integrations and all the e-signatures you can eat. Dropbox removed its unlimited storage tier a couple of years ago due to abuse, but the maximum file upload size of 250GB is still one of the highest available, and it retains deleted files for up to a year. Dropbox also provides payment-free 30-day evaluations.

New members are added to your team by emailing invitations from the admin console. After clicking on the link, users enter their name and choose a password, and you can add extra tasks to the invitation so they are prompted to download the desktop and mobile apps.

Each user receives a personal Dropbox folder and direct access to all shared folders they have permission to see. File-sharing features are outstanding, with the contents of team folders initially available to all members. You can then fine-tune access by deciding who is allowed to see and edit top-level team folders and setting share permissions right down to individual folders and files.

File requests allow you to ask anyone, including those without a Dropbox account, to send you a file. Just create an email request and the recipient chooses a local file and sends it to the folder you've specified.

Dropbox has beefed up data security with full end-to-end encryption. Included in Business Plus, you apply this to selected team folders with sensitive documents, but make sure you store the keys safely as Dropbox can't access them.

PC PRO RECOMMENDED

The abundant collaboration tools include Dropbox Paper, which provides online editing tools so team members can create documents that can be viewed, shared and edited directly from the web portal. Badge supports Microsoft Office files and allows you to see who else is viewing and editing shared files, while automations can be used to sort files, convert them to PDFs, unzip archives and watermark files.

Dropbox does malware protection differently from others: instead of scanning all uploaded documents, it checks them when they're shared. We tested this by uploading malware samples to a user account and when they tried to share them, they were warned that the process had failed and their sharing activity was suspended for 24 hours with the administrator receiving an email alert ten seconds later.

> **"Dropbox Business Plus is a great all-round cloud file-sharing service with smart collaboration tools and lots of app integrations"**

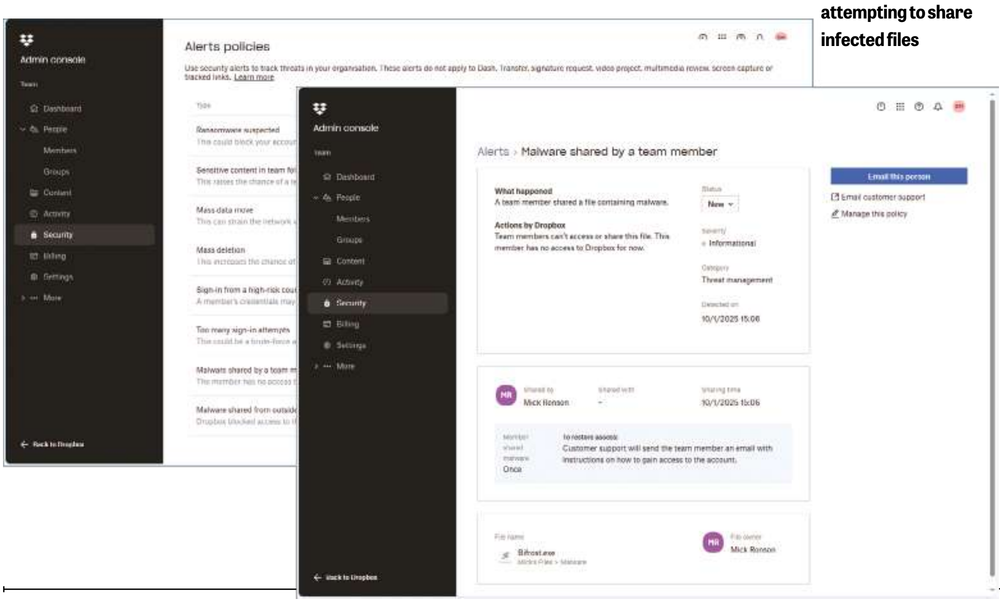
Classification is enabled from the admin console with predefined scan criteria including credit card, IBAN, bank account, passport and NHS numbers. You can apply scans to team and member folders and on completion, Dropbox notifies you that its CSV report is ready for viewing in a separate private folder.

Dropbox Business Plus is a great all-round cloud file-sharing service with smart collaboration tools and lots of app integrations. Malware scanning and data classification services increase security and businesses handling large files will love its huge maximum file size limit.

REQUIREMENTS

Windows 10, macOS 10.13, iOS 15, Android 8 upwards, Linux

BELOW **Dropbox blocks users attempting to share infected files**


Admin console
Team
Dashboard
People
Members
Groups
Content
Activity
Security
Billing
Settings
More
Back to Dropbox
Email this person
Email customer support
Manage this policy

Alerts policies

Use security alerts to track threats in your organisation. These alerts do not apply to Dash, Transfer, signature request, video project, multimedia review, screen capture or tracked links. Learn more

Ransomware suspected

Sensitive content in team fol

Mass data move

Mass deletion

Sign-in from a high-risk cou

Too many sign-in attempts

Malware shared by a team m

Malware shared from outside

Alerts › Malware shared by a team member

What happened
A team member shared a file containing malware.

Actions by Dropbox
Team members can't access or share this file. This member has no access to Dropbox for now.

Status: New

Severity: Informational

Category: Threat management

Detected on: 10/1/2025 15:06

Shared by: Mick Ronson

Shared with: -

Sharing time: 10/1/2025 15:06

Member shared malware: Once

To restore access: Customer support will send the team member an email with instructions on how to gain access to the account.

File name: Bifrost.exe

File owner: Mick Ronson

Egnyte Enterprise Lite

A smart cloud collaboration platform with plenty of app integrations and data governance services

SCORE ★★★★☆

PRICE From £32 exc VAT per user per month billed yearly from egnyte.com

Egnyte is a great choice for businesses that want a cloud collaboration service that snaps into their existing workflows. It supports nearly 200 apps and integrations, and has a keen focus on data security and governance with integral malware scanning, ransomware protection and automated AI-powered classification of documents with sensitive content.

Egnyte's entry-level Team option offers basic file-sharing features and a monthly cost of only £8 per user. At £32 per user per month the Enterprise Lite version on review is substantially more expensive, but it takes everything in the Business edition and adds governance tools such as content lifecycle management and archiving, plus suspicious login and artefact-based ransomware detection.

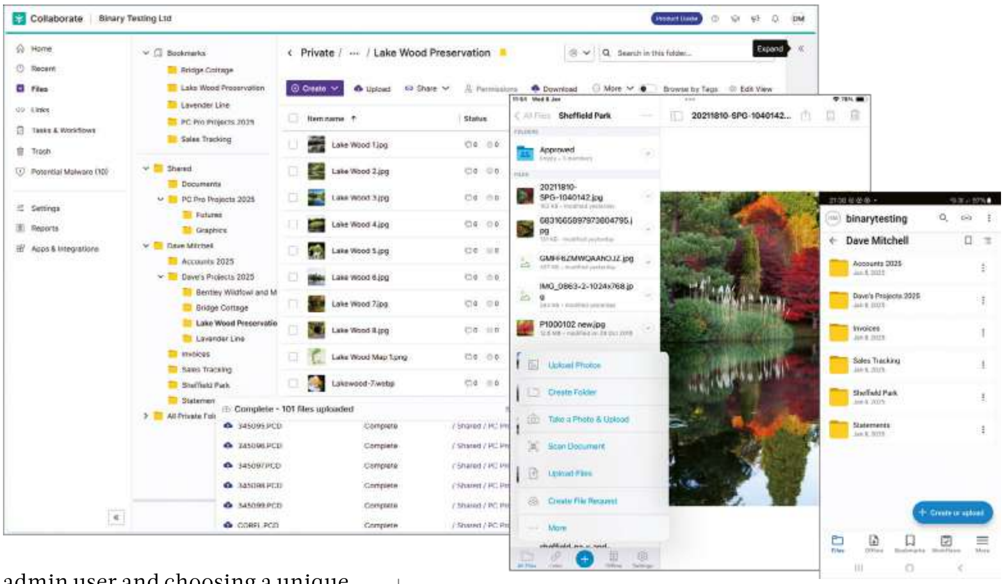
Sensitive data management and compliance monitoring is enabled in the full Enterprise version, with prices available on request. Both Enterprise plans start with a global 1TB of cloud storage, which can be increased on demand, and a feature that will appeal to businesses handling very large documents is that they have a 150GB maximum file upload limit.

A free 15-day trial is available, and it's easy to get started by creating an admin user and choosing a unique name for the sub-domain of your account URL. Using your company name adds extra professionalism when sharing files with clients.

The web portal provides swift access to all collaboration features, and from the Settings page we created new users and assigned a privilege level. You can make your employees power users so they can engage in all file-sharing activities, while external partners are classed as standard users so they can upload and download files, edit them and install the Egnyte mobile apps.

The user web portal has links to desktop apps and, after installing them on our Windows 10/11 clients, they created a new drive for quick access. New to the app are options to sync local folders with the Egnyte cloud, direct links for sharing content and a context menu for starting co-editing sessions.

A feature unique to Egnyte is its Smart Cache hybrid service, which provides fast access to shared data and continuity if internet access goes down. It supports VMware ESXi and Hyper-V and we had no problems installing it on our Windows Server 2022 Hyper-V host.



ABOVE The web portal is easy to use, and Egnyte's mobile apps offer plenty of features

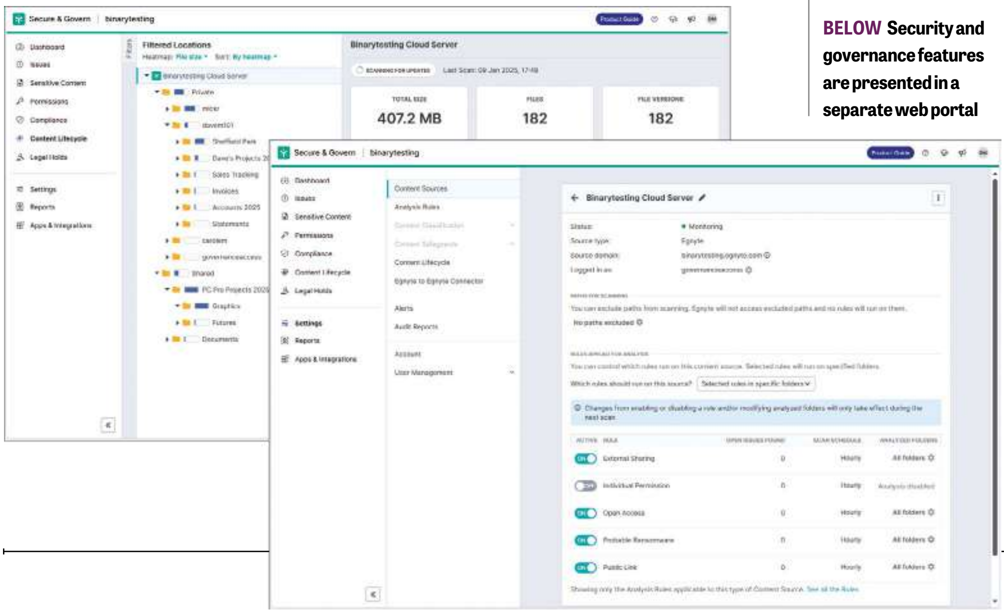
After authorising it with our Egnyte account, we chose the cloud folders we wanted synced, enabled access for specific user groups and added storage capacity and file persistence policies. It handles all connections transparently and automatically swaps to the cloud if a user goes offsite.

> **"A unique feature is its Smart Cache hybrid service, which provides fast access to shared data and continuity if internet access goes down"**

Egnyte's malware protection scans all files uploaded to the cloud and is enabled by default. We tested it by uploading malware samples from a user's account, and all of them were automatically quarantined, with email alerts sent to the admin and user in only 20 seconds.

To use the data governance features, you swap to the Secure & Govern portal. This opens with a dashboard showing open issues, their severity rating, a risk score and the number of sources, folders, files and users being monitored. When we set up our Enterprise Lite domain, it was automatically added as a monitored cloud content source. You can add others such as Amazon S3, Microsoft Azure and Google Cloud Storage, while a site connector allows on-premises storage content to be assigned.

Egnyte Enterprise Lite is a serious contender for businesses looking for a strong combination of cloud collaboration tools and baked-in data security and governance. The price per user is comparatively high, but it delivers a wealth of features including tight access controls, essential malware protection and smart hybrid storage services.



BELOW Security and governance features are presented in a separate web portal

REQUIREMENTS

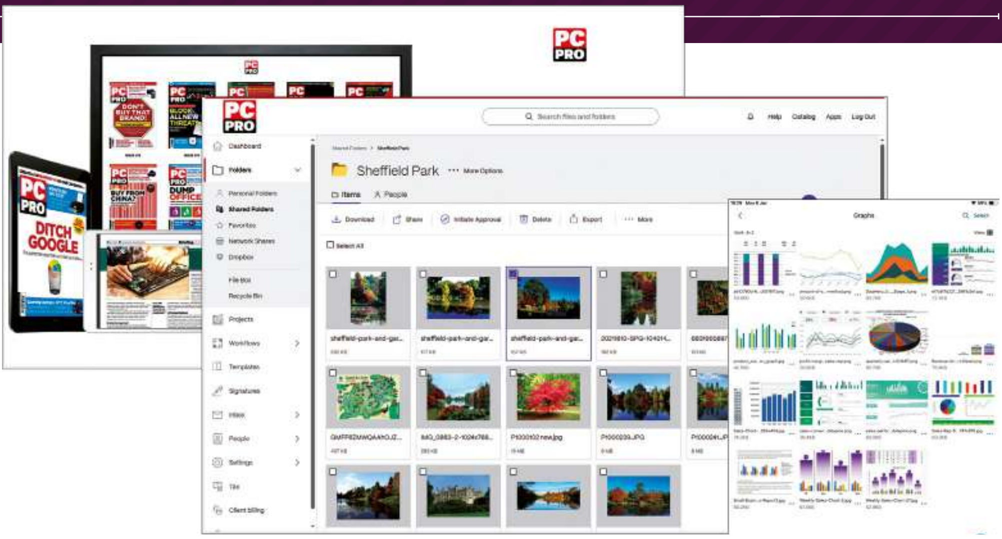
Windows 10, macOS 13, Android 9, iOS 15 upwards

Progress ShareFile Premium

Affordable cloud collaboration with a wealth of features and a sharp focus on data security

SCORE ★★★★★

PRICE £19.90 exc VAT per user per month billed yearly from sharefile.com



ABOVE The ShareFile web portal can be easily customised

Progress Software offers an impressive portfolio of data and infrastructure management solutions, and its recent acquisition of ShareFile adds sophisticated cloud file-sharing and collaboration to the mix. ShareFile is available in a range of plans starting at 1TB of cloud storage per user, with options to upgrade capacity as demand increases.

ShareFile Premium costs less than £20 per user per month when billed yearly, and all plans support a generous 100GB maximum file size. It offers a wealth of features including file-syncing and versioning, custom portal branding, automated workflows, email encryption and malware protection, plus projects and templates for streamlining repetitive tasks.

Unlike most of its rivals, ShareFile supports two different types of user. Only those defined as employees require a licence and are allowed to create and share personal folders, and can have up to 30 privileges assigned such as user management, editing shared address books, using e-signatures and managing billing.

Users external to your business are classed as clients and don't consume any licences so you can create as many as you want. Clients also receive a web portal but can't share or request files and can only access folders and files an employee has invited them to view.

ShareFile's rapid onboarding feature makes it easy to add new clients. It emails one-click agreements with auto-fill templates, provides options to e-sign them and tracks their progress using automated workflows.

Employee creation is just as easy: new users simply receive an email invitation to create their account and password-protect it. Access security has been tightened up, with two-factor authentication (2FA) now mandatory for employees.

The ShareFile web portal is easy to use, with the dashboard providing shortcuts to common activities, a list of favourite folders, the most recent file activity and links to video tutorials. Users can view all their folders, drag and drop files into them, share them with other users and use their personal File Box for temporary storage of incoming file requests.

Employees and clients can download the Windows and macOS syncing apps for fast cloud file access using a mapped drive, and employees can create connections to third-party apps such as Microsoft 365, SalesForce, QuickBooks and Xero. External cloud storage services can also be integrated into ShareFile using the connectors provided for Box, Dropbox, Google Drive, OneDrive for Business and SharePoint Online.

All editions include plug-ins for Outlook and Google Workspace, allowing users to securely send large files. The e-signature service is outstanding: Premium enables virtually unlimited usage where users import Word, text or PDF documents to the web portal, add multiple signatories, arrange the signing order and email them for drawn and typed signatures.

> **"ShareFile scans uploaded files for malware, with automated threat remediation using machine learning to detect suspicious activity"**

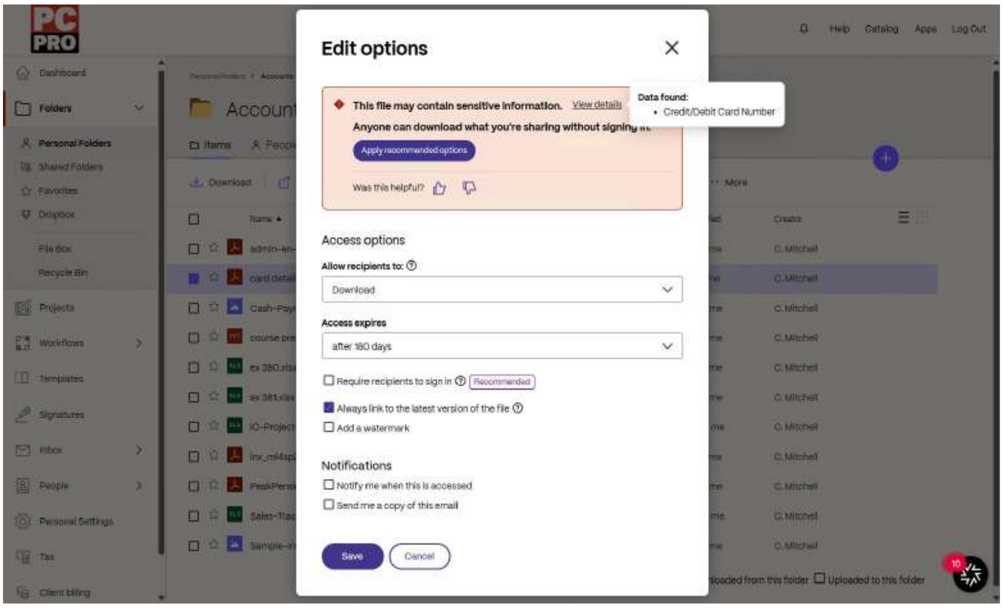
AI power is now in evidence as ShareFile uses it to generate document summaries. Providing the document has fewer than 400,000 characters and is no larger than 20MB, you scan it in the portal's content viewer and ShareFile will produce a concise summary.

ShareFile scans uploaded files for malware, with the new automated threat remediation using machine learning to detect suspicious activity and force a mandatory password change on compromised accounts. In addition, the new secure share recommender kicks in when a user creates a public share link, analyses the file's contents and, if PII (personal identifiable information) is detected, offers to apply stricter access security.

Progress ShareFile Premium will appeal to SMBs seeking affordable and easily managed cloud collaboration services. It offers plenty of app integrations plus support for large file sizes, and the AI-powered features deliver smart security measures.

REQUIREMENTS

Windows 10, Server 2012, macOS 10.15, iOS 14, Android 7 upwards



BELOW A secure share recommender warns against sharing sensitive documents

Edit options

This file may contain sensitive information. View details

Data found:
- Credit/Debit Card Number

Anyone can download what you're sharing without signing in.

Apply recommended options

Was this helpful?

Access options

Allow recipients to: Download

Access expires: after 180 days

☐ Require recipients to sign in (Recommended)
☑ Always link to the latest version of the file
☐ Add a watermark

Notifications

☐ Notify me when this is accessed
☐ Send me a copy of this email

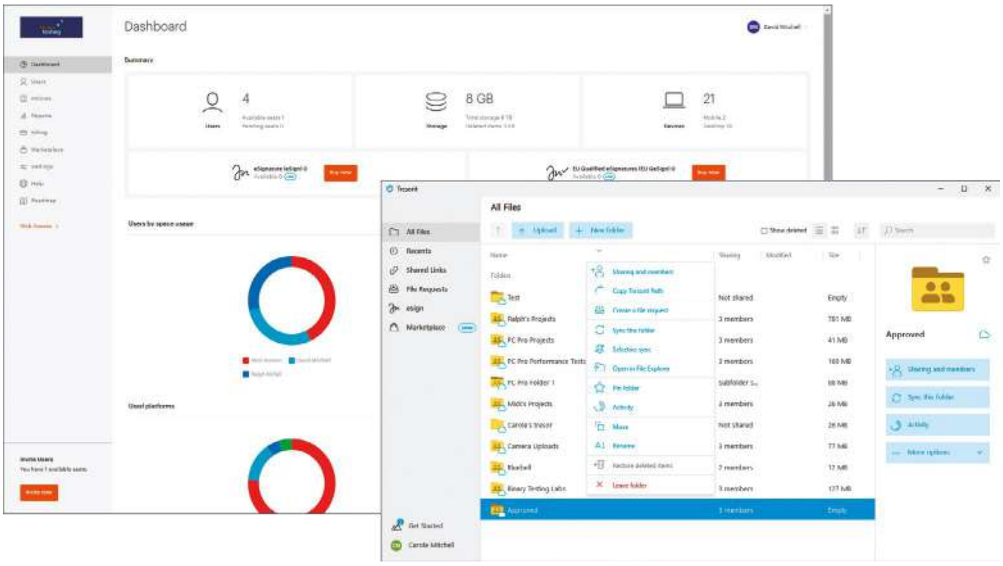
Save Cancel

Tresorit Business

The ideal cloud file-sharing platform for SMBs that won't compromise on data security

SCORE ★★★★★

PRICE £12.83 exc VAT per user per month billed yearly from tresorit.com



LEFT The Tresorit admin portal and desktop apps are very easy to use

SMBs looking for the most secure cloud collaboration platform will love Tresorit Business. Its zero-knowledge policy delivers total end-to-end AES-256 encryption, meaning all data is encrypted client-side, in transit and on Tresorit's cloud servers – no keys or passwords are stored anywhere in unencrypted form so only you have access.

Tresorit offers a choice of plans for individuals and businesses. We reviewed the Business plan, which starts with a minimum of three users. Costing only £12.83 per user per month, this price hasn't changed for a number of years and dishes out 2TB of encrypted cloud storage to each user, supports a 15GB maximum file upload size and offers a choice of 12 global data centres.

E-signatures are optional, but you get to try them out first as the price includes ten free standard e-signatures and six EU Qualified versions. If you like what you see you can buy eSign user licences at £60 per year or pay as you go, with ten standard e-Signatures and five EU Qualified ones costing £3 and £12.50 respectively.

Deployment is swift: invitations are emailed from the admin portal and, after clicking on the link, users create a personal account and choose a password, with the Business plan including password-recovery services. Users are invited to download the desktop app, which creates a personal secure encrypted folder for them.

They can create an unlimited number of folders up to their storage limit. For fast local access, the desktop app creates drive mapping, which worked fine on our Windows 10/11 clients. The older classic folders have now been replaced by next-gen folders that allow top-level folders or selected subfolders to be shared with members and external users.

Access security is excellent, with Tresorit supporting two-factor authentication (2FA) and single sign-on (SSO) using Okta, Azure AD or Google. User activities can be tightly controlled with policies that determine the types of devices from which they can access their account, prevent users from permanently deleting content, block their browsers from storing login details and use IP filtering to limit access from specific locations.

Another feature that impressed us is Tresorit's suspicious activity detector. We had "finger trouble" (if you know what we mean) logging in on a mobile, and after three failed attempts to enter the correct password it automatically enabled email 2FA on that account as a precautionary measure.

PC PRO RECOMMENDED

> **"Its zero-knowledge policy delivers total end-to-end AES-256 encryption, meaning all data is encrypted client-side, in transit and on Tresorit's cloud servers"**

To share a folder or subfolder, users select it from the desktop app or personal web portal, add team members from their contact list and choose the Manager, Editor or Viewer access level. If permitted, users can share files with external users that don't have a Tresorit account, and they can also issue file upload requests and send them to a specific subfolder.

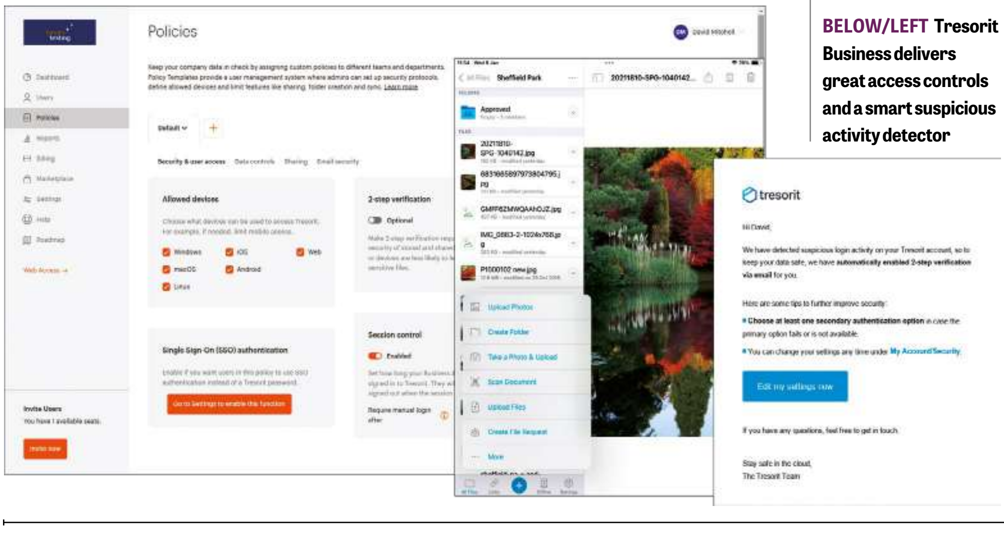
Microsoft Teams integration is included and allows users to share selected folders with other Teams users, upload or download files and create file requests directly from their Teams app. We also found Tresorit's iOS and Android mobile apps very useful as they offer a scanning service that sends documents as encrypted JPEGs or PDFs directly to the user's cloud account without storing them locally.

The new cooperative links feature streamlines collaboration processes by allowing users to securely share documents and receive modified versions over a single encrypted link. Recipients can include external users without a Tresorit account; when they upload edited documents using the same link, the sender will be notified.

Businesses sharing confidential data will find Tresorit the perfect cloud collaboration partner. Total end-to-end encryption and extensive access controls make it highly secure, and the Business plan is an affordable choice for SMBs.

REQUIREMENTS

Windows 10, macOS 10.15, Android 5, iOS 15 upwards, Linux



tresorit

Hi David,

We have detected suspicious login activity on your Tresorit account, so to keep your data safe, we have **automatically enabled 2-step verification via email** for you.

Here are some tips to further improve security:

- **Choose at least one secondary authentication option** in case the primary option fails or is not available.
- You can change your settings any time under My Account/Security.

Edit my settings now

If you have any questions, feel free to get in touch.

Stay safe in the cloud,
The Tresorit Team

BELOW/LEFT Tresorit Business delivers great access controls and a smart suspicious activity detector

Amazon WorkSpaces Thin Client

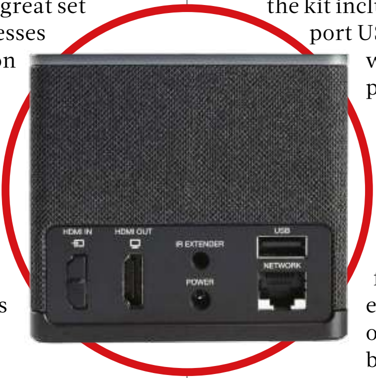
Affordable and secure virtual desktop services in a box with great remote management features

SCORE ★★★★☆

PRICE £192 exc VAT
from amazon.co.uk

ABOVE The Thin Client looks like an Amazon Fire TV Cube – because that's exactly what it is

Amazon is a big name in the virtual desktop infrastructure (VDI) market, and its WorkSpaces offers a great set of features for businesses that want to provision easily managed, secure cloud-based desktops to remote and hybrid workers. It's easy to use, too, as WorkSpaces supports simple web access and offers clients for virtually any device and OS.



LEFT There's an HDMI port supporting 4K UHD output and a 10/100 Ethernet port

The WorkSpaces Thin Client is designed for businesses that want to dispense with their laptops and workstations. You can ship it directly to a remote worker, and they simply plug it in and connect it to a WorkSpaces account.

You'd be forgiven for thinking the Thin Client is an Amazon Fire TV Cube as that's exactly what it is. The only differences are it runs custom firmware and Amazon's Android-based Fire OS enterprise version, with this latest model bringing Wi-Fi 6E connectivity to the table.

It offers an HDMI port supporting 4K UHD output and also has a 10/100 Ethernet port. You only get a single USB port; the HDMI-in and IR extender ports aren't supported, with the kit including a cheap four-port USB extender hub with an extra HDMI port for dual screens.

Amazon offered us login details to a pre-built virtual desktop it had provisioned, but we wanted the full management experience so used our own AWS business account.

The AWS dashboard has a separate section for managing Thin Clients where you configure a dedicated environment.

We chose the WorkSpaces virtual desktop services (AppStream 2.0 and WorkSpaces Secure Browser are also available) and assigned an existing WorkSpace directory that had the requisite web access enabled. When the Thin Client is first powered on you enter the activation code assigned to your environment, after which it updates its OS.

It runs a wizard-based routine to get the essentials configured, but annoyingly it didn't detect the USB hub and our keyboard and mouse during this phase. We replaced it with a dongle for a wireless keyboard and mouse, which worked fine and also reduced cable clutter.

Using the Thin Client is no different to any other client connection method. After entering the WorkSpace registration code, the user logs in and is provisioned with the WorkSpaces VDI environment configured for their account.

Unlike WorkSpaces soft clients, the Thin Client desktop interface has an upper menu for controlling the built-in speaker and microphone. A pop-out sidebar menu offers further controls for disconnecting a session and putting the device into sleep mode or locking, restarting and turning it off.

From the menu's settings, you can configure peripheral devices, enable Bluetooth, set the default volume level for the speaker and choose resolutions for the primary and extended monitors. We used the wired network port but swapping to wireless is simple as the interface shows all detected SSIDs.

During testing, we found responsiveness to be on a par with the WorkSpaces Windows client. Provision a WorkSpace with enough virtual resources for videoconferencing and you'll be pleasantly surprised with the built-in audio components, as the microphone has a good range while speaker output is far better that its size would suggest.

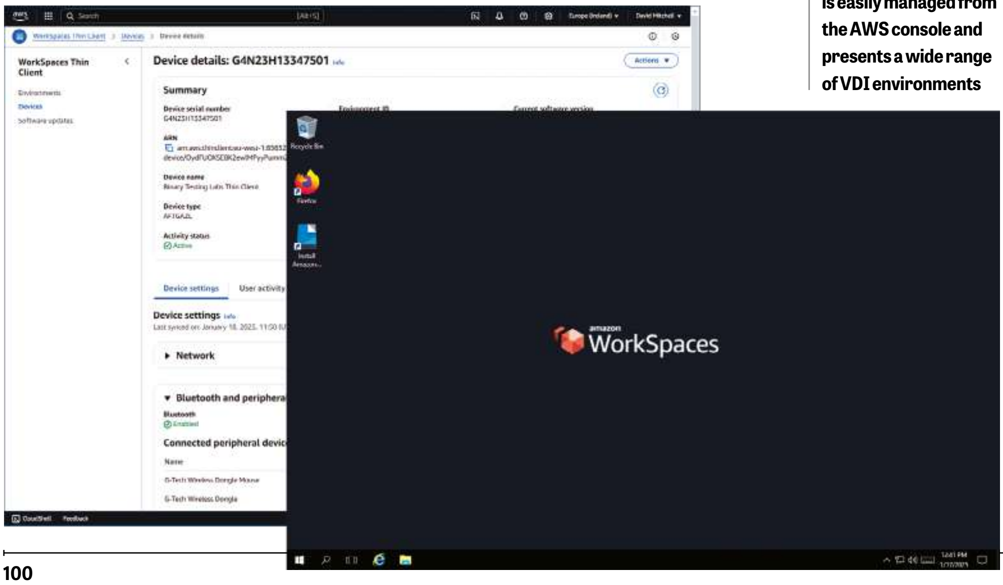
> "The WorkSpaces Thin Client is simple to deploy and can be easily managed from a dedicated section of the AWS management console"

From the AWS Thin Client dashboard, we could choose an environment and see all the devices assigned to it. Select one and it will show whether it's active, what network connection is in use and all attached peripherals.

The WorkSpaces Thin Client is simple to deploy and is a fair deal for the price, as it can be easily managed from a dedicated section of the AWS management console. Amazon offers a heap of Windows and Linux WorkSpaces, with some available in free tiers, allowing businesses to provide secure and easily administered VDI services. The irony is that while Amazon is promoting the Thin Client as ideal for facilitating remote working, it is now demanding that all its staff return to the office five days a week. **DAVE MITCHELL**

SPECIFICATIONS

Desktop chassis • 8-core (4 x 2.2 GHz/4 x 2GHz) Amlogic CPU with 800MHz GPU • 2GB RAM • 16GB storage • 10/100 Ethernet • Wi-Fi 6E • HDMI 2.1 out • USB-A 2 • internal PSU • 86 x 86 x 77mm (WDH) • 513g • 4-port HDMI and USB hub • 1yr hardware warranty



Device details: G4N23H13347501

Summary

Device serial number
G4N23H13347501

Device name
Binary Testing Labs Thin Client

Activity status
Active

Device settings

Bluetooth
Enabled

Connected peripheral devic

Name
G-Tech Wireless Dongle Mouse
G-Tech Wireless Dongle

BELOW The Thin Client is easily managed from the AWS console and presents a wide range of VDI environments

Netgear WBE710

An easily deployed Wi-Fi 7 AP with top cloud management, but its performance doesn't justify the price

SCORE ★★★☆☆

PRICE £270 exc VAT
from broadbandbuyer.com

ABOVE It's physically small, but the WBE710 isn't particularly big on performance, either

Netgear moved into the business Wi-Fi 7 space last year with its WBE750 access point (AP), which offers a mighty BE18400 rating. Its £563 price tag won't endear it to SMBs, though, with the WBE710 offering a more affordable option.

As you'd expect, compromises have been made: the 10GbE port in the WBE750 is downgraded to a 2.5GbE multi-gigabit port and it has a much lower BE9400 rating. On the plus side, the WBE710 supports the ultrawide Wi-Fi 7 320MHz channels and MLO, which allows compliant end-user devices to simultaneously connect to multiple bands on the AP for increased throughput and reduced latency.

LEFT The multi-gigabit port is only of the 2.5GbE variety, rather than 10GbE

The WBE710 can function as a standalone device or be cloud-managed from Netgear's Insight web portal. Measuring only 157mm square and 40mm deep, the WBE710 is probably the smallest Wi-Fi 7 AP on the market, and heat dissipation is handled efficiently by an internal cooling fan behind the front panel.

Standalone deployment is simple as you choose this mode from the AP's local web console. A quick start wizard steps in and after changing the default admin password, you select the country of operations and create an initial secure SSID.

The dashboard shows details such as connection status, client distribution by OS and traffic, plus client and utilisation trend graphs for each radio. The graph also provides views of the AP's temperature and fan activity.

During testing, the temperature stayed at around 60°C with the fan rarely turning on. We forced the issue by putting the AP inside a box, and when it reached 65°C the fan came on, but it's very quiet – we could only hear it with our ear against the front panel.

The WBE710 supports eight SSIDs, and you can make them available across all three radios or on selected ones only and use different security settings up to the mandatory WPA3 for Wi-Fi 7 clients. Advanced features include client isolation, rate limits and basic captive portals using clickthrough or external authentication.

For Wi-Fi 7 performance testing, we connected the AP to the lab's Zyxel XS1930-12HP 10GbE PoE++ switch and used a Lenovo desktop client running Windows 11 Pro 24H2 and fitted with a TP-Link Archer TBE550S Wi-Fi 7 PCI-E adapter. To gauge raw performance, we used the NTttcp utility, which reported upstream and downstream speeds of 232MB/sec and 194MB/sec.

Real-world performance was only a little slower, with large file copies between the client and a Windows server on our 10GbE LAN averaging top close-range speeds of 217MB/sec. Moving the AP ten metres away and into an adjoining room saw copy speeds drop to 182MB/sec.

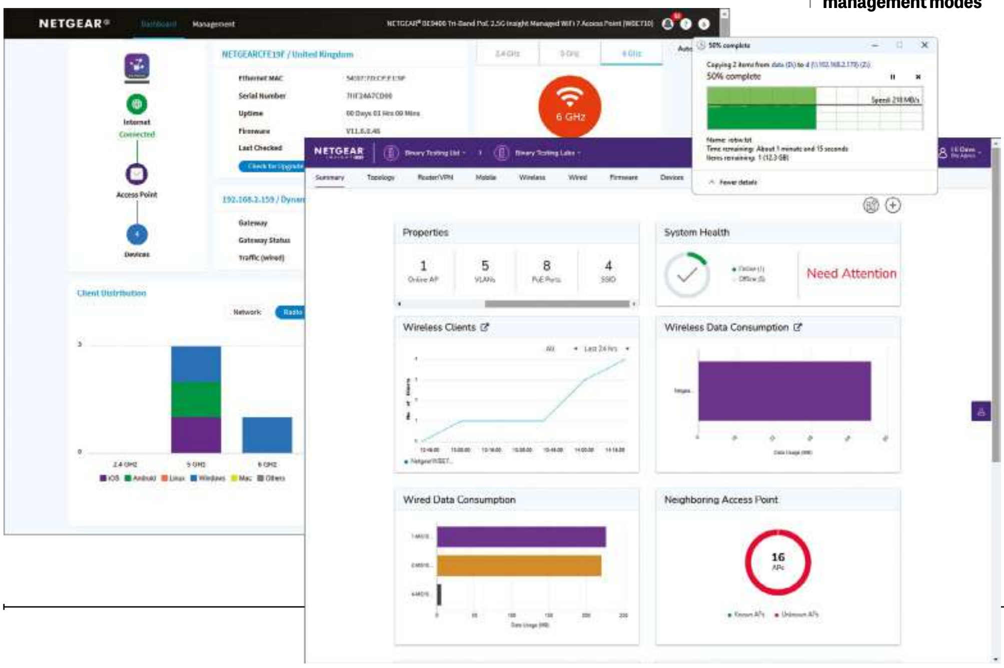
> **"The WBE710 is probably the smallest Wi-Fi 7 AP on the market, and heat dissipation is handled efficiently"**

To add the WBE710 to our cloud account, we used the Insight iOS app to scan its QR code. After it was recognised, we assigned it to a predefined site in our Insight organisation. With power and networking applied, the AP automatically connected to the site and started broadcasting its wireless SSIDs.

Insight provides all the features you'll find in standalone mode but adds extra services including enhanced captive portal services and meshed network creation. One AP that is wired to the network is set as a root device and you expand the network by adding node APs that connect wirelessly to it.

The portal's summary page shows the health of all cloud-managed Netgear devices, an overview of wireless activity and a topology map showing which APs clients are connected to. The Wireless page offers heaps of widgets so you can see graphs of wireless traffic for each AP, client connection trends, their individual data consumption and detected OSes.

For a Wi-Fi 7 AP, the WBE710 isn't good value; TP-Link's EAP772 (*see issue 365, p99*) and Zyxel's NWA130BE (*see issue 365, p101*) both offer similar speeds for half the price. That said, it delivers plenty of business-class features, and Netgear's Insight cloud portal provides excellent remote management services. **DAVE MITCHELL**


NETGEAR
Dashboard
Management
Internet
Connected
Access Point
Devices
Ethernet MAC
Serial Number
Uptime
Firmware
Last Checked
Check for Upgrade
Gateway
Gateway Status
Traffic (wired)
Client Distribution
Network
Radio
2.4 GHz
5 GHz
6 GHz
iOS
Android
Linux
Windows
Mac
Others
50% complete
Speed: 218 MB/s
Fewer details
Summary
Topology
Router/VPN
Mobile
Wireless
Wired
Firmware
Devices
Properties
1
Online AP
5
VLANs
8
PoE Ports
4
SSID
System Health
Need Attention
Wireless Clients
Last 24 hrs
Wireless Data Consumption
Wired Data Consumption
Neighboring Access Point
16
APs
Known APs
Unknown APs

BELOW The WBE710 supports standalone and Insight cloud management modes

SPECIFICATIONS

BE9400 tri-band 2.4/5GHz/6GHz 802.11be • 2x2 MU-MIMO • internal fan • 2.5GbE LAN/802.3at PoE+ • 12V DC power input (adapter not included) • ceiling/wall-mounting plate • 157 x 40 x 157mm (WDH) • 690g • 5yr hardware warranty

Rethink hybrid meetings with the Meeting Owl 4+

ABOVE The Meeting Owl is a one-stop videoconferencing solution for all types of business

Chances are that your remote or hybrid workers are struggling to make themselves seen and heard in meetings – and that has to change

Hybrid working is here to stay, with more than half of all UK employees now working in a hybrid fashion. That's just one key finding from Owl Labs' latest "State of Hybrid Work" report, representing 2,000 workers across multiple industries, company sizes and UK regions (see **owllabs.co.uk/state-of-hybrid-work/2024**).

Another is that keeping everybody in a distributed team on the same page can be a challenge. When meetings mix live and online participants, the latter can be left feeling excluded: two-thirds of workers reported that they found it difficult to contribute to hybrid meetings in 2024.

Technical issues are another barrier. As many as 75% of those surveyed reported that they'd lost time in online meetings due to technical difficulties, with 73% citing audio problems and 72% saying they were unable to see faces properly. It's crucial to address these issues if you want to prevent employees from becoming demotivated, disempowered and ultimately disengaged.

Introducing Owl Labs

Owl Labs is an expert at communications for distributed teams. Its collaboration products are used by more than 225,000 companies – from small offices to 89 businesses on the Fortune 100 list – across nearly 50 countries.

That's thanks to its signature product, the Meeting Owl. This is a one-stop videoconferencing system offering an all-round view of the meeting room, with high-quality close-ups of active speakers and built-in microphones so everyone can see, hear and follow the conversation, whether they're sitting around the table or joining from home. The Owl's illuminated eyes add a touch of personality, or you can turn the LEDs off for a plain, distraction-free look.

Making hybrid working a pleasure

Traditional videoconferencing systems are often limited to a fixed wide-angle view, making remote participants feel like spectators rather than being part of the conversation. The Meeting Owl takes a different approach: place it in the centre of the room, on either a desk or a stand, and its 360° top-mounted camera captures a panoramic view that puts remote attendees right in the middle of the action.

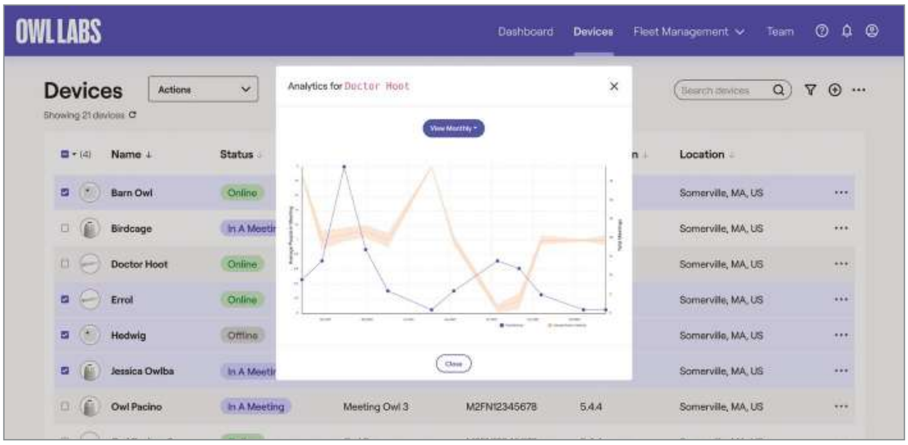
You don't just get an overview, though. The Meeting Owl uses video, voice and AI analysis to work out who's currently speaking, and shows close-ups of current and recent speakers directly below the whole-room view. Those watching online get a proper face-to-face experience, fostering a more natural sense of inclusion and collaboration.

This doesn't only benefit workers who've dialled in from afar: the Owl's speaker tracking is fully automatic, meaning those in the room with the Owl can forget about the technology and focus on what's important – effective, productive communication with no barriers.

Communication is everything

The Meeting Owl delivers uncompromising image quality. The latest Owl 4+ hardware features an ultra-high-definition 64-megapixel camera, enabling it to capture and share 4K video with remote participants. Or choose the more affordable Owl 3, which uses a 16-megapixel sensor, allowing it to frame and share 1080p video of participants sitting up to three metres away.

BELOW All your Owl devices can be managed from the web-based Nest management portal



Devices

Showing 21 devices

Analytics for Doctor Hoot

Name	Status				Location
☑ Barn Owl	Online				Somerville, MA, US
☐ Birdcage	In A Meeti				Somerville, MA, US
☐ Doctor Hoot	Online				Somerville, MA, US
☑ Errol	Online				Somerville, MA, US
☑ Hedwig	Offline				Somerville, MA, US
☑ Jessica Owlba	In A Meeti				Somerville, MA, US
☐ Owl Pacino	In A Meeting	Meeting Owl 3	M2FN12345678	5.4.4	Somerville, MA, US

ABOVE The 360° top-mounted camera captures a panoramic view of the entire room

All-important audio fidelity hasn't been neglected, either. Both Meeting Owl models sport eight omnidirectional beamforming smart mics embedded in their slimline bodies, capable of picking up clear, clean audio from a distance of up to 5.5m. And powerful 360° speakers are built into the base, so those joining remotely can be sure their colleagues will hear what they have to say.

Any size, anywhere

The Owl hardware is super-compact – the Meeting Owl 3 stands 272mm high and weighs a mere 1.2kg, while the more advanced Owl 4+ is a fraction larger at 275mm and 1.5kg. This means your Meeting Owl is effortless to carry and store – and when it's time for a meeting you can deploy it in moments, by simply plugging in the power supply and connecting the USB cable to your host computer.

That makes the Owl perfect for small businesses working in space-constrained environments, while for larger companies it makes a flexible and cost-effective alternative to expensive fixed installations. You really can take your Owl anywhere.

Ease of use and deployment

The Meeting Owl fits seamlessly into your existing communications setup. The hardware plugs straight into any Windows PC or Mac, and functions like any standard webcam. It's certified for Microsoft Teams and works with all other major videoconferencing platforms, including Cisco WebEx, Slack and Zoom.

Since the camera and microphones are all integrated into the main Owl unit, there's no need for any external peripherals or controllers. From the first unboxing you can be up and running in less than six minutes – and once you've completed the initial setup, future meetings can be started in moments.

The Meeting Owl mobile app, for Android and iOS, offers additional settings: you can configure how the camera zooms and locks onto speakers, view usage statistics and download the latest firmware updates. If you're using an iPad, it's even possible to use the app as a live whiteboard for sharing sketches and notes.

Security is everything

Wherever you use it, your Meeting Owl is 100% secure. The unit itself has no recording hardware, and the USB connection to the host PC is impossible to hack. If you use the optional Wi-Fi connection, WPA2 Enterprise encryption is supported for secure wireless connections.

A network connection also lets you use the Nest portal to manage all Meeting Owl products on your network, and ensure they're running the latest system firmware. The Owl is fully compliant with the UK government's Cyber Essentials Plus certification, so you can reassure stakeholders and external partners that your communications meet the highest standards of privacy and security.

In association with

OWL LABS

AWARDS WINNER

PC PRO TECHNOLOGY EXCELLENCE AWARDS 2024 WINNER

"The Owl 4+ stood out from all others for its all-seeing 4K eye, smooth speaker tracking and super sound quality."

Business hardware of the year, 2024

PC PRO RECOMMENDED

Meeting Owl 3:

"No-one else does videoconferencing like the Meeting Owl 3... the smart dynamic split-screen view ensures no participant feels left out."

***PC Pro*, February 2023**

PC PRO ★★★★★ A-LIST

Meeting Owl 4+:

"You'll be impressed when you first use it... the Owl 4+ delivers excellent video quality plus super-smooth speaker tracking"

***PC Pro*, September 2024**

Meetings that grow with your business

The Meeting Owl's ease of use, compact design and three-metre camera range mean it's perfect both for cosy huddle rooms and larger spaces, comfortably accommodating meetings with up to seven in-person participants.

If you need more, the Owl can easily expand to suit your needs. Two units can be paired together to expand video and audio coverage, or you can partner your Owl with an Owl Bar, which provides a fixed 4K front-of-room camera with a horizontal field of view of 114°, ensuring you'll always get the best possible angles of your space and every speaker in it.

The specialist Whiteboard Owl broadcasts a fixed view of a whiteboard or projector screen for everyone, from a distance of up to five metres – with smart technology that makes the presenter translucent, so remote attendees never find their view is blocked.

By combining Meeting Owl and Owl Bar units you can cover over 25 different room configurations, including round tables, classroom-style setups and U-shaped desk arrangements. Official tripods, stands, extension microphones and travel kits extend the system further. And your whole fleet of Owl devices can be managed from the web-based Nest management portal, ensuring everything works together with consistent settings for a professional experience.

It's time to rethink hybrid meetings

Hybrid communications shouldn't be an afterthought – the personal connection is crucial in helping offsite workers stay engaged. Even for those who only occasionally travel or work from home, the Owl can make a big difference to communications and morale. Let's not forget that sometimes you'll be the one at the other end of the line.

Best of all, the Meeting Owl is highly affordable. At only £874 exc VAT for the Meeting Owl 3, or £1,666 for the Meeting Owl 4+, it's cheaper than many in-place installations – and it's portable enough to set up wherever you need it, or to accompany you on trips.

Find our more today – see the Owl in action, browse the specifications and get your own Owl from www.owllabs.co.uk

Choose the right software development model

Waterfall, spiral or agile? **Nik Rawlinson** picks through the most popular approaches to development – and asks which you should be using for your next project

Modern software development methods might seem a world away from the early days of punch-card programming, but it turns out that some things are timeless. Winston Royce was a computer scientist for Lockheed Martin and TRW in the 1960s, working on space mission planning, orbit selection and developing the software on which America's rapidly expanding space sector relied. As part of this work, he wrote an influential report advocating a standard approach to producing code – particularly for large projects – which split the overall development cycle into seven steps. Each stage fed into the next, like a cascade of waterfalls where each drop lands in a pool that goes on to feed the next fall.

Today, Royce is widely credited with inventing the "waterfall model", as used in software development worldwide – though similar practices had been in use at least a decade before, and there's some doubt as to whether he ever actually used the word "waterfall". Regardless, his report was one of the first documents to clearly set out a method of software development. Waterfall remains in use today alongside methodologies such as agile, incremental and iterative.

Which is best? It depends on your circumstances and the nature of the project. Each has its strengths and weaknesses; the trick is identifying the most appropriate model for your job and using it to drive your workflow.

FOR LINEAR PROJECTS

Waterfall and V-model

For projects with clearly defined objectives and interim milestones – such as putting a man on the moon – waterfall makes sense. It's particularly appropriate where, although several rounds of testing may be conducted as part of the development, the results aren't expected to change the overall goal of the project. NASA still uses the waterfall model for some projects, but its contractors may have adopted more agile processes (see below).

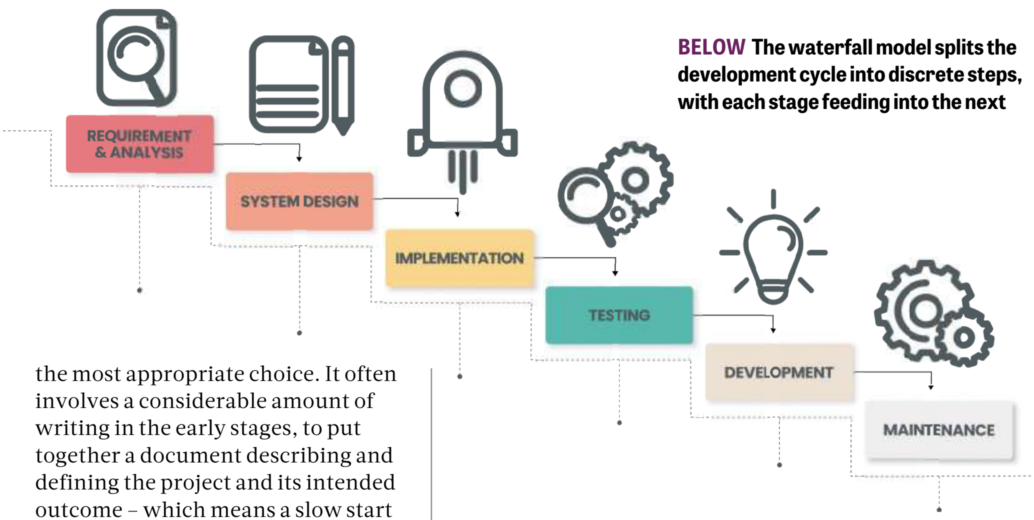
A classic waterfall project proceeds through somewhere between five and seven phases, depending on how you choose to break them up. It starts with collecting requirements and analysing them to build conceptual models and rules for the desired system. The next phase is designing the software architecture itself, then implementing that as code. After this comes testing and debugging to ensure the code works as planned, before the final phase of deployment and ongoing maintenance of the code.

"Waterfall still has a place," said Brian Cowe, a senior product manager at OpenText, an information management firm that was formerly part of HP. "Most obviously that's when the requirements are fixed, where you're going out to tender and know exactly what you want – or you don't know exactly but you do have a fixed price for a known tranche of work."

> **"For projects with clearly defined objectives and interim milestones – such as putting a man on the moon – waterfall makes sense"**

Cowe points to several sectors where such conditions can prevail, including in large companies, government and defence. In the latter, the body putting out to tender might know what they want but not be able to talk about how it will be used. "So, you can't have the kind of conversation in defence that you might well have in an agile business."

Waterfall is well understood and comparatively easy to manage, but its linear nature means it's not always



BELOW The waterfall model splits the development cycle into discrete steps, with each stage feeding into the next

the most appropriate choice. It often involves a considerable amount of writing in the early stages, to put together a document describing and defining the project and its intended outcome – which means a slow start with significant overhead.

Waterfall is also inflexible by nature. If the project brief changes during development, earlier steps may need to be unpicked, and the later the change is ordered, the higher the cost can be. This isn't just expensive – it actively discourages late-stage innovations or course corrections, potentially impacting the quality of the finished product.

To address this, in 1979 a US-based software engineer named Barry Boehm developed a variation of waterfall called the "V-Model". This is an evolution of the waterfall model in which V stands for both "validation" and "verification" – reflecting the fact that, simply put, it adds testing at the end of each phase. This can help in finding and remedying issues earlier in the process, but it's still not the most flexible option for teams working on rapidly evolving projects.

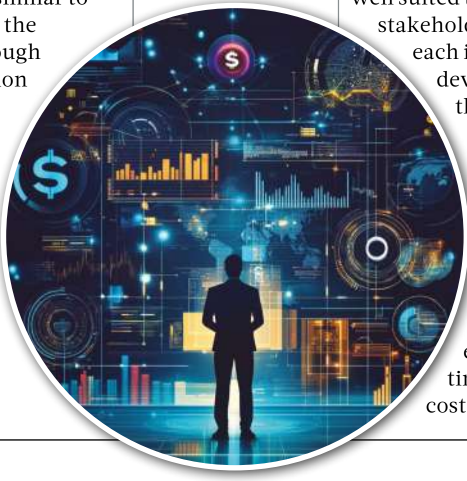
FOR EVOLVING PROJECTS
Iterative and spiral development

While space missions usually have clearly defined objectives, commercial coding projects often evolve throughout the production cycle as developers gather feedback from test users or feel their way towards an outcome that was unclear at the outset.

This may be addressed by an incremental approach. This is a multi-phase model that's similar to waterfall – but rather than the whole project moving through the pipeline from description to design and coding, development begins with a simple, core function of the software. This is fully created and tested in isolation before work begins on the next component – meaning it's quicker and easier to backtrack or change course should that become necessary.

> "The spiral method is particularly well suited to projects with multiple stakeholders who need to sign off each iteration"

BELOW The spiral method can lead to spiralling costs



A more organic version of this is the iterative development model, where the project as a whole alternates between coding phases and testing phases that inform the next cycle. As regular evaluations and reworkings are built into the schedule, there's again an opportunity for changed priorities and requirements to come to light during the development process, and for the code to be adapted accordingly.

The downside of an iterative approach is the degree of uncertainty it involves. Management permitting, there's no limit to the number of iterations the code may go through before it's deemed ready for release, and the final product could be quite different to what was originally envisioned. If businesses aren't happy to accommodate that, they may prefer the spiral development model – innovated in 1986, also by Barry Boehm. The process looks similar to waterfall, with four phases defined as planning, risk analysis, development/testing and evaluation; these can be repeated over and over to refine the product until it's ready to deploy, but the intention is to "spiral out" from the original design requirements, rather than allowing them to be changed or redefined.

The spiral method is particularly well suited to projects with multiple stakeholders who need to sign off each iteration before the development team moves to the next phase. It can also be good for more speculative, exploratory projects, as it allows for early termination if things aren't going well. The flipside is that repeated pauses and feedback-gathering exercises can extend the development timeline and accompanying costs indefinitely.

While most testing is carried out by internal stakeholders, this needn't always be the case. During the development of *World of Warcraft*, publisher Blizzard carried out extensive testing with volunteer players – and the scale of the testing proved revealing. Aside from any issues with the code itself, the developers discovered that some test players never left the game and needed to be given incentives to log off and do something else for a while, before their gaming habits became unhealthy. A new update was created that progressively reduced the amount of "experience" players would gain as their session grew longer. Had it not incorporated these ongoing tests with external stakeholders – its players – Blizzard might not have discovered the issue, or developed the solution, until after the game had shipped.

FOR NON-LINEAR PROJECTS
Agile development

Some projects can be clearly outlined on a GANTT chart, showing how each developmental step follows on from (and often relies upon) its predecessor. But that isn't always the case: often, a project can be divided into discrete tasks that don't need to be completed in sequence. For example, an interface designer may be able to work on fonts and graphics for an e-commerce website at the same time as coders are building the shopping cart and copywriters are crafting product descriptions.

These are scenarios where the agile development model comes into its own. In fact, agile isn't just a methodology but a movement, founded by a group of coders calling themselves "The Agile Alliance" and defined in 2001 by the "Agile Manifesto" (**agilemanifesto.org**). Today there are several agile models in use, but they all have common features, notably the fact that team members can work in isolation or as small groups – accelerating the process as multiple teams complete their tasks simultaneously.

Perhaps the most popular agile model is scrum, an approach that involves coding in a series of "sprints", frequently lasting two weeks or so. At the beginning of a sprint, each team member has a limited, defined objective for what they're expected to achieve by the end, such as producing a new module or building upon a previous milestone. Goals will often be set by a product owner or project leader, with tools such as Kanban boards used to assign tasks and monitor ongoing progress.

Because scrum programming focuses on short-term goals, it's perfect for modular tasks such as

→

updating an online application. It's also suitable for projects that are iterative by their nature, with each stage making the product just a little bit better. "You've got one, two, maybe three teams, and the deliverable isn't set in stone, maybe isn't even known at the beginning," said Cowe. "It keeps changing, and you can just carry on iteratively on an ongoing basis."

Working in sprints can put pressure on coders, but it also gives them purpose and clarity, as they're working with a clearly defined objective and a manageable timescale, rather than creeping towards a distant, nebulous goal. At the end of a sprint there's usually a period of reflection and analysis, providing an opportunity to pick up any problems quickly, rather than proceeding too far in an impractical or unworkable direction.

The bite-sized nature of scrum can, however, also be a weakness. For large-scale government contracts or enterprise projects, stakeholders often want to talk about what can be achieved over the next six, nine or 12 months, and the overhead of managing a lengthy string of fortnight-long work phases becomes significant.

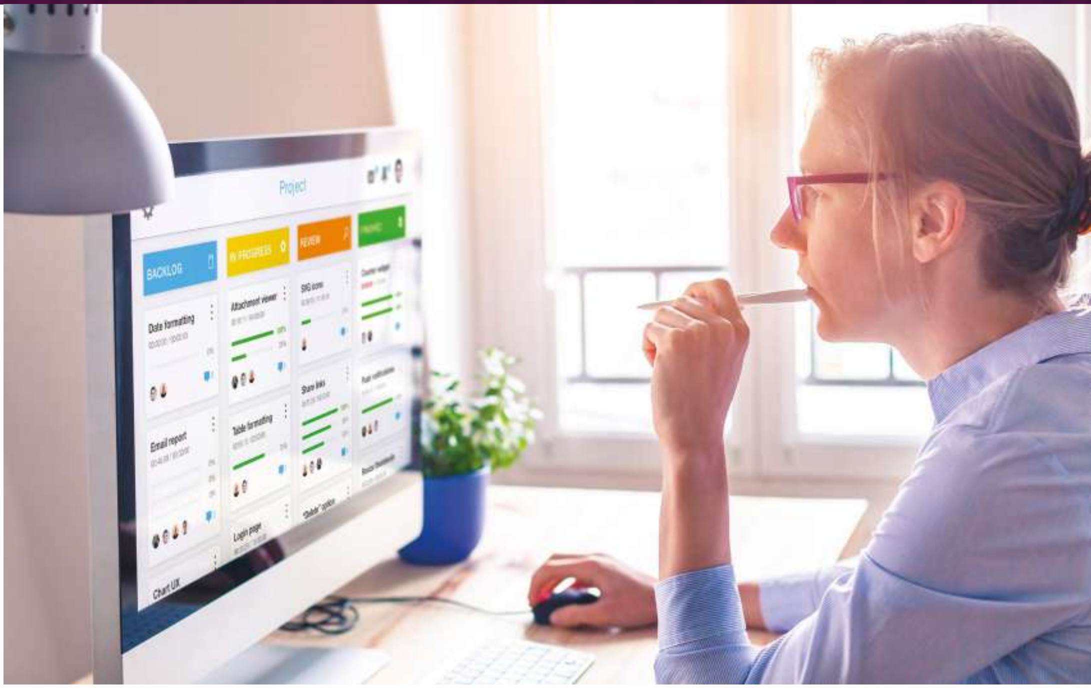
FOR MULTI-DIMENSIONAL PROJECTS

Hybrid development

Another management challenge arises when projects become too big or too sensitive to be handled by a single team. Such was the case with the development of the original Apple iPhone, which was done in such secrecy that, prior to the launch, nobody outside Apple knew what it would look like or how it would work. A 2008 article in *Wired* magazine discussed how iPhone development teams had been "split up and scattered across Apple's campus... even the iPhone's hardware and software teams were kept apart: hardware engineers worked on circuitry that was loaded with fake software, while software engineers worked off circuit boards sitting in wooden boxes."

In such cases, it may be necessary to come up with a hybrid approach that incorporates elements from multiple different development models. For example, you might choose a waterfall model for developing documentation but use an agile model during periods of development and testing. Medical device or vehicle manufacturers may rely on V-Model for underlying systems, but again turn to agile processes when developing the user interface. Both might adopt a spiral model when testing each build.

By drawing on the best of all worlds, a hybrid model can be moulded to the specific design requirements of a particular product component or corporate culture. At the same time, combining multiple approaches is very likely to increase management complexity – not least when it comes to helping team members understand how the project is structured and where they fit into in the workflow.



ABOVE Many large projects will be best served by a hybrid development model

IDENTIFYING THE RIGHT MODEL

So how do you decide which is the right approach for a given project? Should you be guided by the particular characteristics of the product you're hoping to build, or is it more about the environment and culture your product will be developed and used in? I put the question to Brian Cowe and – after a pause – he suggested that it was "probably bigger than either, to be honest".

That's hard to argue with. A successful project is founded on many things, including a team that works well together, a point of focus and a sense of direction – even if the latter needs a little adjusting once development has begun. And although the models we've explored each have their standard definitions, their implementation will vary from product to product, organisation to organisation, and even between teams within those organisations.

The choice of model can also change over time, even if the product itself doesn't – one huge example of this being Microsoft Windows. The anonymous author of the **engineerseekingfire.com** blog notes that early versions of Windows were developed via a waterfall methodology, so each time a new version of the operating system was planned, the leadership team would begin by setting out general targets, from which organisation directors would start to draw up goals and instructions for developers to contribute to the overall strategy.

The result was a huge, complex project that took many years to progress from the original vision to a boxed product. Most notoriously, after the release of Windows XP in October 2001, the company wasn't ready to make Windows Vista generally available until the start of 2007. The next two major versions between them hung around for another eight years.

After that, though, everything changed. Windows 10 was rumoured to be the "last edition" of the operating system – reflecting the fact that, internally, the company had moved from infrequent major releases to an iterative development model. Rather than spending years working on the next version of Windows, Microsoft would now evolve the OS with smaller updates twice a year. At the same time, it embraced a much broader testing regime – the Windows Insider programme, which allowed stakeholders (AKA users) to test new features and provide feedback while development continued.

> **"The choice of model can change over time, even if the product itself doesn't – one huge example of this being Microsoft Windows"**

This isn't only happening at Microsoft. The whole world of software development is changing, and while the classic waterfall model still has a place, its days may be limited. "You can't find a project in the corporate world that keeps the same requirements at the end that it had at the beginning," said Cowe. "That's just not a thing now. The world is moving too fast – so people's requirements are changing too fast." ●

What is AGI?

It's the holy grail of AI – but as Steve Cassidy explains, businesses shouldn't wait for artificial general intelligence

Is this just another label for the same old AI hype?
Well, yes and no. If you ask a passerby in the street what AI means to them, their answer might in fact be a definition of AGI – short for artificial general intelligence. The term refers to an AI that's so broad and versatile that it can mimic the intelligence and functions of a human. To be clear, though, a genuine AGI wouldn't be just a dumb copycat – it would be a free-thinking entity in its own right.

How does this differ from the various types of AI we have today?
The idea of emulating organic intelligences is a fundamental step beyond the workings of ChatGPT and Google Gemini. Natural systems learn by gaining and losing connections in a neural network. This is the only way it happens, and it doesn't take many neuron-like structures to make a very effective decision-making system. One famous example is the Nematode Worm, which doesn't really have anything like a brain at all, but uses a total of 302 neurons to execute all the usual objectives of a living thing, from eating, eliminating, fighting and running away to reproducing and raising offspring.

That sort of breathtaking efficiency is well beyond modern AI – which is infamously inefficient. Part of the issue is that in biology there are factors such as "principal genes", which determine things such as how many legs and how big a head you will have. There's no corresponding structure in AI: most networks are trained by being fed simulated cause and effect information. Creating an environment in which the full variety of human brain connections and functions can be emulated is still a distant pipe dream.

So this is a futurist vision rather than a real technology?
The technology isn't here yet, but people have been thinking about it for a long time. Alan Turing himself developed some highly influential ideas about AI, almost as an aside to his work in machine computation and cryptography. One is the insight that any digital device can emulate any other, provided that they're capable of a tiny selection of simple operations. Thus, if the human brain is any sort of computer, it *can* be emulated with today's technology. That doesn't mean it's likely to happen any time soon, though.

Why so pessimistic?
While earthworms may get by with a few hundred neurons, the typical human brain comprises 96 million brain cells, forming a network of possibly 10 trillion interconnections. It's not impossible to replicate that on a computer: we have databases that big already. But to build such a model in a way that operates like a brain – and, crucially, that functions in anything like real-time – is going to be an enormous task. Experts suggest we won't see anything that can be meaningfully labelled as AGI until 2040 at the earliest. When you consider how quickly "regular" AI is advancing, that's a long way off.

So how is all this going to help my business?
In the short term, it's clearly not. But that's all right – most businesses don't need it anyway. The famous Turing Test (yes, him again) doesn't ask whether an AI is really emulating the workings of a human brain, but focuses on whether the user can tell the difference. There are plenty of AI technologies available today that can handle specific tasks and answer questions just as well as a human – so you can get on with reaping the benefits of AI right now, without needing to wait for machines that can laugh, love and philosophise. ●

How to identify an AGI

While there's broad agreement about what the idea of AGI implies, opinions differ as to exactly how an AI system might qualify for the title.

Google's AI engineers have suggested that an AGI is differentiated from a regular AI by its ability to generalise what it's learnt in one field to another, allowing it to "adapt to new and unseen situations effectively". They also suggest that an AGI should be able to draw on "common-sense knowledge", allowing it to reason and operate according to cultural norms and understandings.

IBM conversely has drawn up a list of individual competencies that must be mastered by the AI to qualify as an AGI. Visual perception, audio perception, fine motor skills, problem-solving, navigation, creativity and social and emotional engagement are all identified as requirements.

Perhaps the most ambitious approach to AGI comes from OpenAI, which focuses on the roles that the AI can take. Five levels of AI agency are defined, ranging from single-function chatbots to problem-solving "reasoners", executive "agents", creative "innovators" and ultimately "organisations" – anticipating that a fully realised AGI will be capable of operating an entire business autonomously with no human involvement.

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Real world computing

Expert advice from our panel of professionals

JON HONEYBALL

"Wouldn't it be nice if someone produced a properly designed, rack-mountable NAS that just did file storage?"

Continuing his flirtation with Ubiquiti devices, Jon welcomes its NAS solution into the lab – but is less impressed by Microsoft bundling Copilot into Office 365 Family with a bump in price

Jon is the MD of an IT consultancy that specialises in testing and deploying kit

𝕏 @jonhoneyball

What sort of storage do you need, both in your home and in your business? Larger organisations have many choices, with multiple enterprise solutions available. These have a whole range of capability requirements that are well outside the scope of the home and SME marketplace: it is, quite simply, a different world.

But choices in the SME space are interesting. The standard play here is a network attached storage (NAS) device to which all the clients connect, usually via SMB protocol. This covers all the day-to-day operation of laptops, desktops and servers. However, in the server space, you will often need iSCSI – and NFS, for those who have longer memories – to provide a more efficient block-level connection to storage.

The NAS itself has changed shape, too. In the past, it was essentially a big box of disks with a relatively simple controller, feeding out the storage in a managed way using the required protocols. By "in a managed way", I mean that it's vital to slice and dice the storage between multiple users, and to do so in a coherent and secure fashion. This requires user account management, permissions and groups, plus the means to properly audit the settings.

However, there has been a move to make NAS boxes into much more than mere storage. Now we expect to run services on them, and this can be anything from traditional server functions such as mail and DNS services through to exotic capabilities such as surveillance video. More recently we've seen the rise of virtualisation capabilities such as Docker, along with full virtual machine services. So a modern NAS is often a full-blown server offering services and capabilities onto the network.

The need for that big box of disks hasn't gone away, however, because there has been an almost inevitable rise in prices of NAS-as-server products to cover the cost of the expanding features.

So wouldn't it be nice if someone produced a properly designed, rack-mountable NAS that just did file storage? And at a price that made cost of entry very affordable, where the final outlay was determined by the amount of storage you fitted to it rather than paying a big overhead cost for the box itself?

> **"There has been a move to making NAS boxes into much more than mere storage"**

That's why I was interested to see the launch of Ubiquiti's UniFi UNAS Pro (**tinyurl.com/367unifi**). It's a 2U rack-mountable box (if you fit the flanges) that can take seven hard disks. And it costs only £380 plus VAT. You choose what disks you want to fit to it, and it will happily take both 2.5in and 3.5in drives.

At this point you could be forgiven for wondering whether you're reading last month's column all over again, but then I was talking about the company's Dream Machine Pro network appliance. It's not entirely coincidental, as there are advantages of being part of one family of products.

The UNAS Pro is actually a repurposing of the existing UniFi Network Video Recorder Pro (**tinyurl.com/367unifi2**), which costs the same. But the OS platform is different on the UNAS Pro, there's no video security software included, and it has a bunch of NAS functions instead. Incidentally, there's a 16-bay "Enterprise" version of the video recorder, too, raising the prospect of a NAS equivalent in the future.

The chassis itself is well built, as you'd expect from Ubiquiti. It's powered by a single mains socket on the rear, and there's no option of a second built-in mains supply. However, you can use the UniFi Power Backup unit that provides power to six UniFi devices if you want to add redundancy.

Connectivity is on the front and consists of a 1GbE port for backup access and a 10Gb SPF socket. You can obviously fit whatever interface you want into this. For example, if you want a fibre connection to an upstream switch, then there's a 10GbE multimode fibre SFP module that will drive fibre up to 300 metres. It costs £34 for a two-pack, plus the fibre itself.

First UniFi-ing steps

I started with a 10GbE Ethernet SFP unit, so I could wire it into my 10GbE aggregation switch. This switch has

BELOW Ubiquiti's UniFi UNAS Pro can take seven hard disks

@PCPRO FACEBOOK.COM/PCPRO Real world computing

Jon Honeyball Opinion on Windows, Apple and everything in between – p110
Lee Grant Tales from the front line of computer repair – p113
Olivia Whitcroft Lawyer Olivia offers legal advice for the tech industry – p116
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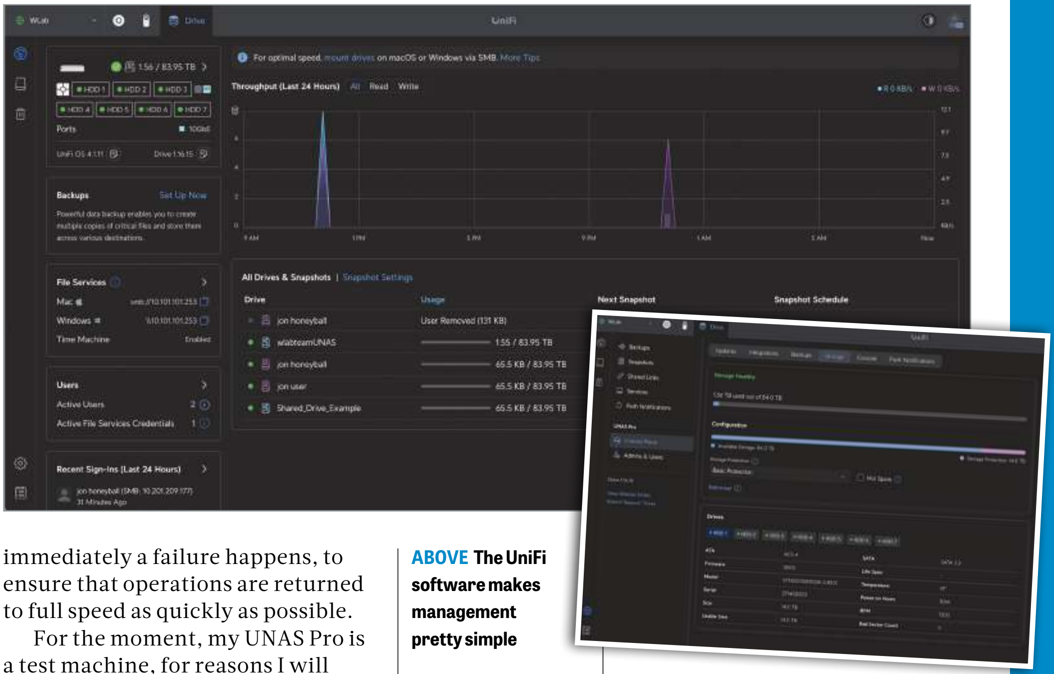
Steve Cassidy The wider vision on cloud and infrastructure – p120



For optimal speed, mount drives on macOS or Windows via SMB. More Tips

Powerful data backup enables you to create multiple copies of critical files and store them across various destinations.

Mac smb://10.101.101.253
Windows \\10.101.101.253
Time Machine Enabled

Active Users 2
Active File Services Credentials 1

Recent Sign-Ins (Last 24 Hours)
jon honeyball (SMB: 10.201.209.177)
31 Minutes Ago

All Drives & Snapshots | Snapshot Settings

Drive	Usage	Next Snapshot	Snapshot Schedule
jon honeyball	User Removed (131 KB)		
wlabteamUNAS	1.55 / 83.95 TB		
jon honeyball	65.5 KB / 83.95 TB		
jon user	65.5 KB / 83.95 TB		
Shared_Drive_Example	65.5 KB / 83.95 TB		

ABOVE The UniFi software makes management pretty simple

28 ports of 10GbE SFP sockets, plus four SFP 25GbE ports for trunking.

At £58 per SFP, it's a fairly expensive way to connect things up, but gives the flexibility of allowing Ethernet cabling. However, I soon replaced it with a 10GbE SFP-to-SFP direct attach cable – it's like a network cable but with SFP plugs on each end. A half-metre one of these is 12 quid, and even the five-metre version that I bought is only £35. It freed up two SFP Ethernet adapters, which is a good thing for connecting normal devices at 10GbE. These direct attach cables are definitely the way to go for connecting up nearby high-speed servers.

So that got the box plumbed in, and now I needed to populate it with hard disks. My go-to drives for a while have been the IronWolf Pro disks. They have worked well for me in my collection of Synology NAS servers.

The obvious choice was the 14TB model. On offer at a well-known retailer, they were just £205 each (including VAT), which came to a total of £1,435. That is quite ridiculously cheap for 98TB of storage. All in, the price for my 98TB of storage was £1,435 plus £456, so £1,891 including VAT. Throw in an SFP interconnect and we are knocking on two grand.

Fitting them was easy: just pull out the drive tray, snap the drive in – no screws required – and pop it back into the unit. Once powered up, the web interface is rich and easy to navigate. It doesn't require a UniFi fabric controller or other UniFi devices, but there are integration advantages if you have that.

The next decision is how you want to carve up this storage. Currently, Ubiquiti allows only one pool of storage. You can't take three drives and use them entirely separately from the other four. You must use all seven (assuming you have the maximum) in one pool. Maybe this will come in a future update.

It's necessary to decide how best to use the storage, to allow for the failure of a drive. Now this is almost a religious topic for some people. Some say you should cover yourself for the failure of two drives, known as RAID6. Some say that you should have a hot spare lined up in the machine so that rebuilding can start immediately a failure happens, to ensure that operations are returned to full speed as quickly as possible.

For the moment, my UNAS Pro is a test machine, for reasons I will come on to. And because of that, I'm happy with a straight RAID5. In this configuration, I have seven active drives. Parity checksum is calculated and spread around them all. This reduces the available storage by one drive's worth, but means I can lose one drive and the array will still be intact. I could then replace the failed drive and rebuild the array again. When in the failed state, failure of a second drive would destroy the array.

For a production environment, where this would be the primary storage for important stuff, I would certainly consider RAID6 where two drives are used for parity, and hence I could lose two drives at once. Ubiquiti calls the basic RAID5 format "Basic Protection"; RAID6 is called "Higher Protection". You can also enable Hot Spare if you wish.

An alternative view would be this: 98TB of storage for two grand is almost insanely cheap, even when you end up with 84TB in a RAID6 arrangement. Why not have a second unit, and put that somewhere else on the network, assuming you have a decent 10GbE backbone across your site?

BELOW Seagate's IronWolf Pro disks are my go-to drives

SEAGATE
IRONWOLF PRO
NAS
18TB

Then make sure all data is replicated from one to the other. It's actually really easy to do this within the UNAS configuration, because it can do direct transfers to another unit.

Performance? I haven't had time to move enough data to the storage to see how well it handles files. Some reports suggest this is improving with each build of the software.

I've set up some accounts, and use the tools to create SMB mount points for client machines, so getting files on and off is as easy as a drag and drop. I particularly like the built-in file-sharing capabilities. Choose a file or folder, click on File Link, and a link is automatically generated. This can be a straight URL or a QR code, although I try to avoid them as you're never really sure of their provenance. It's possible to set an expiry date, a maximum number of allowed downloads and a password too. This negates the need for services such as WeTransfer if you're sending files to clients or friends.

What don't I like? Well, it's early days, both for me and for this platform. It appears to be iterating quite rapidly, and my confidence

ABOVE The mirroring of the iPhone on the Mac is incredibly well implemented

in it is growing. I'm not wholly convinced by the account management, especially around home folders for each user, but I suspect this will get fixed shortly.

At the moment, it's an excellent product to get a stonking amount of storage on your network for very little money. If you're already on the UniFi platform, then the integration is useful but not critical. I'll give it some months before running this as the core of my network, but all devices must prove themselves before they can step up to that task anyway.

So if you want storage, and just storage, and don't want to load up the box with a pile of server functions, this has to be on the radar. The biggest problem is availability: the UNAS Pro is out of stock almost all the time, and I had to wait a number of weeks before it became available. But I'm glad I bought one, and I'm tempted to buy a second to build a matched pair.

Drive firmware

While on the topic of those seven 14TB IronWolf Pro drives, I found something odd. You might not think about this, but drives have firmware. And there's a case to be made for keeping drive firmware up to date, or at least keeping an eye on what's happening in that space.

All of the drives are identical ST14000NE0008-2JK101 models. However, six of them have firmware SN03 and one has SN02.

Now, should I care about this? There's precious little information out there, either on the broader internet or on Seagate's website, about what to do. Indeed, it's almost completely opaque about what steps are required to update a hard disk's firmware.

It's not surprising that this is the case – it would be unreasonable to expect a NAS unit to be able to rewrite the firmware of a drive. It can be done if all the components come from the same vendor, though. Synology has its own-brand drives, and when fitted to a Synology NAS you can update the drive firmware directly. But I wouldn't expect Synology to update an IronWolf Pro drive any more than I would expect my UNAS Pro to do the same.

Nevertheless, it's annoying my OCD, and I fear there's a rabbit hole here that I will fall down quite quickly. I may be some time.

> **"I fear there's a rabbit hole here that I will fall down quite quickly. I may be some time"**

iPhone mirroring

It's a little feature, but it has totally taken over my daily working. I now mirror my iPhone onto my laptop or desktop and operate it as if I was actually using the phone itself. It means that the phone can be left docked on a charger, and I don't have to keep looking up and down between main screens and the phone.

This isn't new functionality, but it's implemented in a very fluid way here and works over Wi-Fi. And I'm now using it all the time. Performance is excellent, with no lag or stuttering. If I had a criticism, it's that it would be nice to be able to resize the virtual phone to something a little larger, but that's probably for my ageing eyesight.

I realise I can do a very similar thing on my Windows desktop – Microsoft even offers a prompt to do so during its setup process – but I've never taken advantage. Whichever platform you're on, it could be most useful in business meetings where you can check something on your phone without making the rather obvious gesture of picking it up. Stealth operation wins every time.

Copilot on Office

The price of Office for home users is going up. It's not a small rise, either, going from £80 per year to £105. This is for the Family edition, which allows a number of people in your family unit to have access to all the client-side tools plus a bunch of OneDrive storage each.

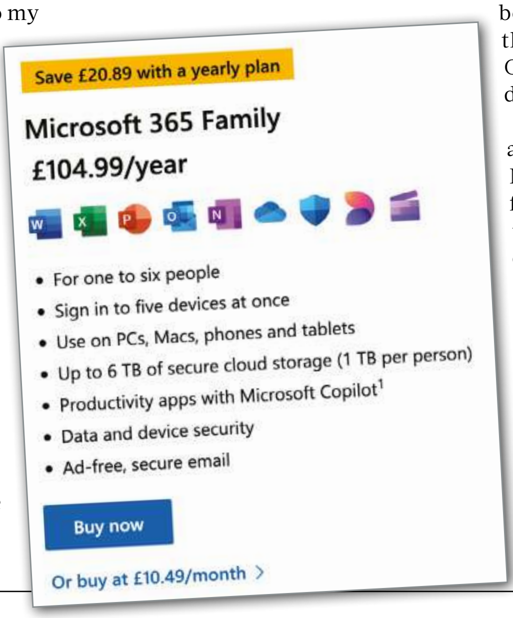
There's no doubt in my mind that this remains a bargain. Those of us with long memories will recall Microsoft Word for Windows costing around £400 per seat in 1989, and that's not taking inflation into account.

Nevertheless, the reason for this price hike is that it has been Copiloted, whether you want it or not. And many people are less than impressed with Microsoft pushing Copilot AI features into their Office suite and then having to pay extra for the privilege.

You can revert to your old package if you're prepared to complain to Microsoft. It will then move you to something called Microsoft 365 Family Classic, and the price is miraculously back where you were before. You miss out on the Copilot features in the Office apps, but then you didn't want them anyway.

I'm in two minds about this. Clearly Microsoft needs to get AI features out in front of users. If I may quote the old Guinness advert, "I've never tried it because I don't like it". How will people get to understand the benefits if it's not there?

Well, Microsoft, the answer is actually quite clear. Throw the Copilot features in for a year for free. Then offer users the



Save £20.89 with a yearly plan

Microsoft 365 Family

£104.99/year

- For one to six people
- Sign in to five devices at once
- Use on PCs, Macs, phones and tablets
- Up to 6 TB of secure cloud storage (1 TB per person)
- Productivity apps with Microsoft Copilot[1]
- Data and device security
- Ad-free, secure email

Or buy at £10.49/month ›

BELOW Microsoft 365 Family's price has shot up, with Copilot included whether you want it or not opportunity to renew without Copilot or stump up the relatively small amount of cash to continue in their newly blissful AI world.

That’s how things should work. Microsoft shouldn’t be upping the price, adding in the feature, and then hiding away the old version. And making that available only if you complain.

That, dear Redmond, is commonly called entrapment.

If I may be unusually cynical (who, me?), I might suggest that Microsoft has a big uphill battle to show Copilot adoption. What better way than to railroad your Office home subscribers into taking it, and then being able to crow that it is a huge hit?

After all, there are shareholders who need to be reassured that Microsoft’s eye-watering expenditure on data-centre hardware, including a substantial bill for AI capabilities, is delivering the required return on investment. Otherwise they might get nervous.

Uncomfortable Parallels

The latest version of Parallels, the virtual machine environment that runs on Apple, now allows you to run an Intel-CPU virtual machine on an M series processor. Well, it kind of does, and that’s being generous. Admittedly, the read-me file for this release warns that it’s very slow indeed. And has extremely limited capabilities in terms of choice of CPU cores and amount of RAM assigned, both of which are currently fixed.

I tried it on my M4 Pro Mac Mini and it refused to start up an Intel-based virtual machine. I fiddled with things and then gave up.

Frankly, this shouldn’t be in a production release and should only be available as a beta preview. Even calling it “beta” would be generous. I’m not impressed by companies pushing things out like this even when accompanied by much hand-wringing.

Why has it done this? Maybe Parallels needs to raise the technical bar over VMware’s Fusion, which is now free for all users, including businesses. Free is a lot cheaper than £100 per seat per year. That price comparison is going to sting, however you try to spin the tech.

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LEE GRANT

“HP thinks it’s okay to kick everyone off the train at Derby when we’re meant to be in Truro”

This week’s Any Questions asks: is half a service better than no service? Can a printer use a potty? And what was wrong with that mouse?

Lee Grant and his wife have run a repair shop in West Yorkshire for over 20 years
@tnargeel.com

To set the scene, this month’s column comes to you from platform 2 of Derby railway station. I am surrounded by grumpy travellers who, like me, weren’t planning on being in Derby. Those well-remunerated executives at CrossCountry railways have seen fit to add a frisson of excitement to our journey from Yorkshire to Cornwall by cancelling most of it.

Despite the millions that have been splurged on the travel apps being bombarded by myself and Derby’s other surprise visitors, the consensus is that the information appearing on our devices is incorrect and not to be trusted.

Here and now, on this platform, technology has lost the dressing room. Still, this incident offers me the opportunity to drop a segue that clunks louder than the points just south of Long Eaton, because getting the wrong information is often the bane of my fixing life, too.

Panel beater

One joy of being an independent business is the ability to say “no” to jobs that, frankly, have nightmare written all over them. It’s a liberty that’s often overruled by the fixers’ instinct to make a situation better, improving life for a customer.

> “One joy of being an independent business is the ability to say ‘no’ to jobs”

When Tony called to talk about his HP’s smashed screen, I agreed to take a peek. How much worse could I make things?

The machine was an HP Pavilion All-in-One PC from mid-2021, and persons unknown had given it a wallop and punctured the panel.

As you may imagine, the fix is straightforward. Remove broken screen, fit replacement screen, hand back to customer, take payment, then wonder if pushing trolleys at Asda would be more profitable. The devil in the detail is getting the part.

HP has long been one of the best manufacturers at providing service manuals for its machines. Right to Repair legislation now dictates that this must be provided, but like many aspects of the technological sphere, what should happen is very different to what actually happens (more on this next month).

HP’s manuals for Tony’s AIO are strange. Although it has useful diagram explosions of the machine and detailed step-by-step disassembly routes, it lacks any information about parts. HP normally provides part numbers, but not this time. It’s like buying a cookery book that lists the method but omits the ingredients.

Mercifully, Tony’s HP was listed in the HP parts store, which isn’t always a given. Many HP machines are either unlisted or unfindable, and experience has left me of the opinion that HP hasn’t really focused on spares retail.

BELOW The screen on the HP all-in-one didn’t paint a happy picture

If the HP parts store were a normal shop, it would have gone bust. The Parts Store’s listing for Tony’s AIO has no images, and the product descriptions have either been written by AI or an under-assistant who hasn’t been allowed near daylight for some time. It’s curious that HP can masterfully sell new products, but doesn’t provide the same satisfying retail experience for parts.

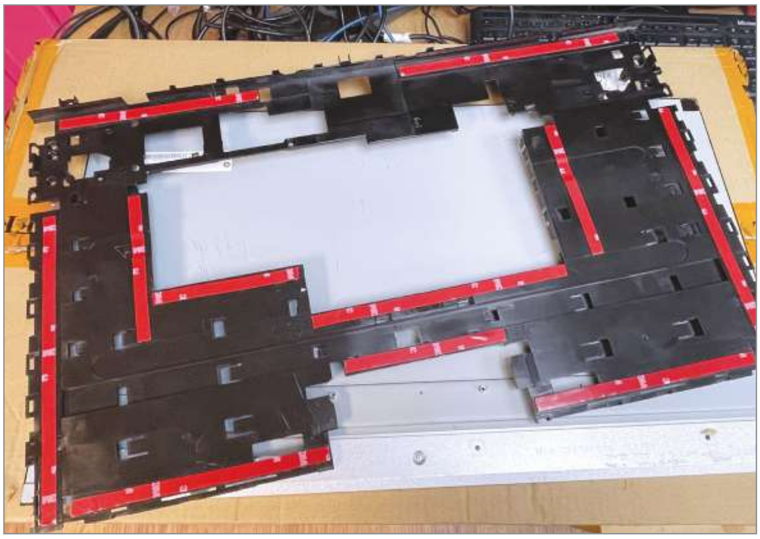
More troubling is that most of the parts for Tony's HP are listed as out of stock, and I suspect that none of them was ever in stock. The only part that's available is a 512GB SSD priced at £139. HP's pricing for this is robust, at around £100 over the RRP. In retail, this pricing structure is the opposite of a loss leader, the loss loser – a product so poorly priced that people distrust the retailer and shop elsewhere.

What I inferred from the Parts Store was that the line-item listed as "27, FHD, IPS, 300nits, BV, 3S, Slim, AUO" is the screen. As mentioned, there was no availability, but at least I now have a price (£283) and a part number (L17303-381) to work with. A few hours later, I found a UK supplier, and before you think that xenophobia is my New Year's resolution, going with a British company is my post-Brexit preference should I ever need to return the part to the supplier.

To its credit, HP had designed the AIO so that the screen was incredibly simple to remove. It has also released the step-by-step video tutorial (normally for its service agents) so even a muppet like me can't get it wrong. Although this is a genuinely great thing and perhaps even progressive, it should also be the absolute minimum in terms of repair documentation. These companies spend squillions creating blockbuster-grade videos to sell products, but they all spend considerably less on some quick tutorials to fix their products.

Once the screen was out, I spotted something unexpected. Attached to the back of the panel was a large plastic-formed bracket which had the simple purpose of being the mechanism with which the screen will sit into the chassis. As the replacement screen didn't come with a bracket, I'd have to reuse this part. Naturally, the bracket was glued to the screen, so I spent a merry hour attacking it with a fistful of spudgers and a 250°C heat gun.

After cleaning it up, I pulled the replacement screen from its wrapping and wired it into the AIO to check for transport breakages. That's our free good-practice tip for this month: always test before affixing. Once I'd discovered that the screen had survived its journey, I taped up the plastic bracket and, taking advantage of my own free advice, checked the positioning on the replacement screen. As you've probably guessed, it didn't fit, and the reason for this won't be found in any of HP's documentation.



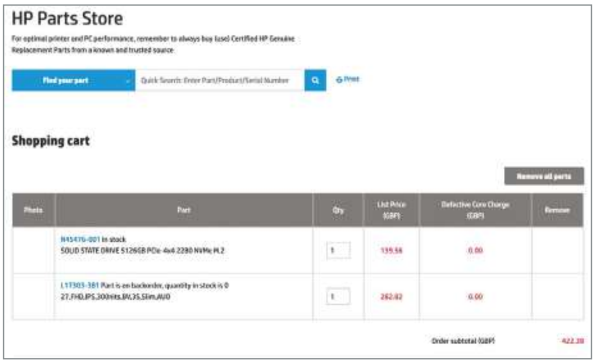
ABOVE You've been framed – or not, in this particular case

My supplier had sent me the correct HP part, L17303-381, but this number is largely meaningless outside of the HP ecosystem. The LCD panel that I'd been sent was labelled as an M270HAN01.1, whereas the original screen is M270HAN01.3. The difference between the two was physical, the upshot being that the plastic retention bracket fitted to the original screen doesn't fit on the replacement.

Why so many part numbers? M270HAN01.X is the model number of the screen that HP decided to fit into the AIO before re-labelling it with its own part number, L17303-381. I'm making the assumption that the HP part number is a "compound-part", comprising the LCD-panel and frame as one. This would explain why there's no reference to either M270HAN01.1 or M270HAN01.3 on the HP site. To the end user it matters not which version is dispatched as long as it comes with a frame that fits.

Sadly, my replacement didn't. My supplier also didn't have a M270HAN01.3, nor did any of my other trade suppliers. A handy solution would have been to try to obtain the correct bracket for the M270HAN01.1, but there's zero product information about this. The bracket I removed wasn't marked with any codes or references.

"Our free good-practice tip for this month: always test before affixing"



HP Parts Store

For optimal printer and PC performance, remember to always buy (use) Certified HP Genuine Replacement Parts from a known and trusted source

Shopping cart

Photo	Part	Qty	List Price (GBP)	Defective Core Charge (GBP)	Remove
	N45476-001 In stock SOLID STATE DRIVE 512GB PCIe 4x4 2280 NVMe M.2	1	139.56	0.00	
	L17303-381 Part is on backorder, quantity in stock is 0 27,FHD,IPS,300nits,BV,3S,Slim,AUO	1	282.82	0.00	

Order subtotal (GBP) 422.38

BELOW The HP Parts Store had no mention of the model number of the screen in its AIO

For the completists in our readership, I discounted trimming the original frame to fit as this would have removed one of the main anchor points, and having the screen drop out on the unsuspecting user is not what anyone needs.

Sadly, I couldn't fix Tony's AIO because I couldn't fit the replacement panel. Let's all take a moment to appreciate how utterly ludicrous this situation was. By creating great documentation, HP is doing great things in promoting the repair of its products. But it's all utterly pointless when its unfit-for-purpose parts-retail means that a simple screen repair can't happen. To clunk this metaphor back onto the rails, HP thinks it's okay to kick everyone off the train at Derby when we're meant to be in Truro.

Epson's waste of time

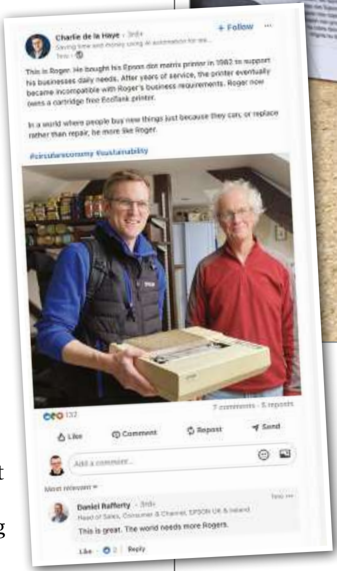
HP is far from alone in making repair far tougher than it should be. If you have an Epson inkjet printer, you'll be familiar with the "this printer needs servicing" type of message. This is triggered by an internal software counter, which brings the whole machine to a standstill until the clock has been reset. As a *PC Pro* reader, you're probably aware of the various websites that will sell you a code to fix this "error".

The usual reason for the error is that the printer's waste tank needs emptying (*see issue 326, p114, for an excruciating explanation*) and, you know, sometimes it does. Ruby brought her hard-working Epson EcoTank ET-2860 into the shop as the servicing message had pinged. I cleared that, but on checking the waste tank, I could see that it needed to be emptied.

Again, credit where it's due. Epson has made the replacement of this tank very easy. A few years ago, finding the waste tank inside a printer required a partial rebuild, which was made more complicated by a lack of

documentation. Only two standard-headed screws held Ruby's waste tank in place, so it was out in a few moments. These are decidedly low-tech components, a simple plastic pot filled with some absorbent pads and not a wire or PCB to be found. Oddly, my Epson parts supplier didn't have one listed, and nor did several others. The ones I spotted listed on shadier retail sites also appeared to be a mismatch.

I contacted Epson's customer support, and a friendly operator informed me it doesn't sell or supply the part either. Clearly keeping a stock of the key components of a nappy are utterly beyond the wit of a multi-billion-dollar company. For giggles, I asked Epson how to get the EcoTank running and was offered an attractively priced service. For £54, Epson would collect the EcoTank, reset the counters, replace the waste tank and deliver it back to Ruby. The entire process takes about a week and, if you think about it for any longer than a microsecond, is completely insane.



Charlie de la Haye · 3rd+

+ Follow

This is Roger. He bought his Epson dot matrix printer in 1982 to support his businesses daily needs. After years of service, the printer eventually became incompatible with Roger's business requirements. Roger now owns a cartridge free EcoTank printer.

In a world where people buy new things just because they can, or replace rather than repair, be more like Roger.

#circulareconomy #sustainability

132 · 7 comments · 5 reposts

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Most relevant

Daniel Rafferty · 3rd+

Head of Sales, Consumer & Channel, EPSON UK & Ireland

This is great. The world needs more Rogers.

Like · 2 | Reply

Like many tech companies, Epson will look you in the eye while evangelising about its environmental ethos and green corporate strategy. Don't gaze over its shoulder at the billions of empty ink-cartridges peeking out of landfills; look into its eyes and soak in that greenwashing.

I contacted Epson's press office, questioning its commitment to reducing carbon, and asked whether it would be a "greener" strategy to depreciate servicing and supply waste tanks, rather than burn unnecessary carbon shuttling working printers up and down the country. You may not be surprised to know that it didn't respond. In the end, I carefully rinsed Ruby's absorber pads under the tap and all was well again.

While researching this story, I found a Facebook message from Charlie de la Haye, Epson's PR and social media manager. In the post, he's photographed replacing Roger's 1982 (apparently) dot-matrix printer with a complimentary EcoTank.

Lucky Roger! Charlie says: "In a world where people buy new things just because they can, or replace rather than repair, be more like Roger."

Stirring sentiments, though the expression on Roger's face suggests that owning a modern printer was only number two on his list of "things to avoid before I die", just below anaesthetic-free vasectomy.

Charlie wasn't alone in celebrating this event. Daniel Rafferty, Epson UK's head of sales, chipped in with: "The world needs more Rogers."

Environmentally speaking, Epson has already rogered the world quite enough. If it's genuine about improving its environmental footprint, it needs to turn off the bogus DRM gimmick and let people buy waste tanks. If Epson PR is reading, feel free to get back to me.

Christmas quiz winners

A huge thank you to everyone that entered our Christmas quiz (*see issue 364, p115*). I'm delighted to announce that absolutely no-one got the answer correct. In all honesty, I expected this, so every entry went into the hat, giving everyone an equal stab at a prize.

ABOVE Removal of a waste tank by Epson takes about a week and will set you back £54

LEFT Be more like Roger? If only, Epson, if only...

"In the end, I carefully rinsed Ruby's absorber pads under the tap and all was well again"

BELOW What was wrong with the mouse? It was dead

If you missed the quiz (and call 0330 333 1113 to subscribe so you don't miss this year's), it went something like this. A desktop PC that shut down when gaming arrived in the shop. The fault wasn't any of the usual suspects such as GPU, CPU, RAM or thermals, but a problem with the mouse. Our question, which everyone failed to answer, was "What was wrong with the mouse?" The very simple answer being that it was dead.

The mouse in question was (probably) called Nibbles and I suspect he'd come to a sudden and shocking end. During the diagnosis for the machine I'd wired in a test PSU, and the PC had been stable when I'd given the GPU some things to do. I removed the customer's PSU and discovered Nibbles "sleeping" behind it. I think he'd been asleep for some time, as he was rather stiff.

Nibbles was removed and given an appropriate burial, but a post-mortem revealed a probable cause of death. One of the PCIe power lines had a small nick, a mouse-bite, which had broken the wire. The GPU was still receiving enough power to function, but when it called for more, it didn't arrive, crashing the machine. One can only presume that Nibbles took a bite while the machine was at full tilt and the wattage was high.

Anyway, Andy Cooper wins a copy of *The Long History of the Future* by Nicole Kobie, and Carl Waring bags *It's a Gas* by Mark Miodownik. Paul Leach wins the mystery third book, a rare unsigned copy of *The Computers That Made Britain* by Tim Danton. Thanks to everyone who entered and congratulations to our winners. And really, do subscribe, or how else will you take part in the next quiz?

lee@inspirationcomputers.com

OLIVIA WHITCROFT

“My colleague and I spent three days in Paris visiting the sights and drinking *bouteilles de vin*”

If you aren’t *au fait* with governing law, you may be giving *carte blanche* to the foreign company you’re working with – and that would be a *faux pas*

Olivia is principal of the law firm OBEP, which specialises in technology contracts, IP and data protection
𝕏 @ObepOlivia

About 15 years ago I went on a business trip to Paris. While it sounds glamorous, the purpose was to attend a data room. It wasn’t a modern-day data room, which requires just a laptop, internet connection and multi-factor authentication to visit, and you can come and go as you please. This was more like a less fun version of an escape room, where you’re trapped in an underground chamber and not allowed to leave until you’ve decoded all the paper documents within.

We’d been sent there in connection with the purchase of a French firm. We were acting for the purchaser, who wanted to review the target company’s contracts, to check they weren’t going to expose it to significant risks – if, for example, the sale could trigger the termination of key contracts, or if it would be tied in to long-term agreements with unreasonable costs. Some French lawyers had been in the data room for a while, and had discovered a lot of English-language contracts, so they had shipped us over from London to review them.

We arrived at the data room on our first day and surveyed what lay ahead. There were many contracts to review. I picked one. Being a wily lawyer, rather than starting at the beginning and working my way through, I skipped to the end, where the governing law clause usually is. *“The provisions shall be governed and interpreted in accordance with the laws of Ontario.”* That’s in Canada, isn’t it? I’m an English lawyer, so this one isn’t for me.

I selected another contract: Ontario law, too. One by one, we went through the contracts that had been set aside for us, to discover that they were all governed by the laws of Canada. Yes, they were in the English language, but they weren’t governed by English law. English lawyers weren’t needed to review them; Canadian lawyers were.

> “We discovered that the contracts were all governed by the laws of Canada”

So, as it turned out, it was a rather glamorous trip after all. My colleague and I spent three days in Paris visiting the sights and drinking *bouteilles de vin*.

BELOW **Contracts often include a clause about governing law**

Why care about governing law?

The challenge started several hundred years ago as the foundations of common law were forming from decisions of the courts. These started to evolve into modern-day contract law in the 19th century, with famous cases such as *Adams v Lindsell* (1818). The courts have since decided thousands of cases that help us to interpret contracts. The common law is supplemented with legislation addressing particular issues, such as implied or unfair terms.

At least, this is the case in England and Wales. In many other European countries, there’s a Civil Code: legislation clearly defining the main principles of contract law. Other common law countries (such as the US or Canada) may have started based on English law, but have since diverged with their own cases and statutes.

All this means that contracts may be written and interpreted very differently depending on which law applies. If there’s a dispute, the courts use the governing law to work out the parties’ obligations and whether there has been a breach. And this isn’t just about interpretation of the express words written in the contract. It includes determining what other terms may be implied into the contract, or which terms may be unenforceable and therefore struck out.

Which law applies?

Many jurisdictions permit the parties to choose which country’s law will govern their contract. The court will then interpret the contract in line with the chosen law (which may be different to the laws of the court’s country). In the UK, this choice is given by rules deriving from the EU’s *Rome I* Regulation.

So it’s common for a contract to specify the chosen law. As not all countries may respect such provisions, it’s worth checking for unfamiliar jurisdictions. Last year I was reviewing a contract with a party in Uruguay, and my client wanted it to be governed by English law. Uruguay has only recently passed a law that allows the parties to choose this.

If no governing law is specified, there are rules for working out which law applies. Under *Rome I*, for a consumer contract it would be the law of country where the consumer is resident; for a B2B services contract, it’s where the service provider is resident.

Of course it’s not quite as simple as that, as some types of contract may be excluded from the rules (such as, under *Rome I*, arbitration agreements), and some laws cannot be overridden by a choice of law (including, under *Rome I*, protections given to consumers and employees). In addition, issues connected to the contract may be subject to different laws, such as data protection laws (which depend on where the parties are established) and intellectual property laws (which depend on where the intellectual property subsists). There’s also a *Rome II* Regulation that determines applicable law for some non-contractual matters.

Plus there’s the question of which country’s courts (or other forums) have jurisdiction to hear a case relating to the contract or other matter. This requires us to look at the rules for choice of jurisdiction.

Pulling myself back from these complexities and the inevitable confusion they lead to, I’m going to focus on the main law governing a contract, as chosen by the parties.

Let’s play a game

Sometimes it’s fun not to skip ahead to the governing law clause, but to guess what law applies from the way a contract is drafted. I’m going to give you some clues about four mystery contracts, based on some I’ve seen recently. Your mission is to identify the governing law, and escape from my article.

Mystery Contract A

- **Clue 1:** Long sentences with lots of synonyms: *"You agree not to reproduce, duplicate or copy any information, data, content, materials, products (including software) or services…"*
- **Clue 2:** Archaic language: *"The supplier hereby agrees it shall forthwith not use the herein-afore-after-mentioned deliverables."*
- **Clue 3:** CAPS LOCK KEY SEEMS TO HAVE GOT STUCK WHILE DRAFTING THE LIABILITY PROVISIONS.

Write your answer here:

The correct answer is: the laws of a state of the US (in this case Illinois).

Wordy sentences with seeming repetition can evolve from not wanting to miss out anything where words have slightly different meanings, and are potentially interpreted differently depending on the context. Archaic language also still remains in some English-law contracts, but we appear to have done better at modernising in general.

The stuck caps lock key derives from the need to ensure provisions that exclude liability are sufficiently conspicuous to be enforceable.

Mystery Contract B

- **Clue 1:** Unable to understand it as it's written in Dutch.

Write your answer here:

The answer is: probably governed by the laws of the Netherlands or Belgium. Best to double-check given my Paris experience.

Mystery Contract C

- **Clue 1:** Nicely structured, not too long or complex, clear drafting and easy to understand.
- **Clue 2:** Parties must act reasonably, follow reasonable instructions and take reasonable steps to achieve the goals.
- **Clue 3:** OBEP brand appears in the header.

Write your answer here:

The correct answer is: the laws of England and Wales.

English-law contracts often use the word "reasonable" a lot. To determine what actions a reasonable person would take, we look to 100-year-old case law and consider what the "man on the Clapham omnibus" would do in a similar situation.

Mystery Contract D

- **Clue 1:** Distinct lack of requirements to act "reasonably"; instead the parties must act with "due diligence".
- **Clue 2:** Keeps using the "§" symbol, particularly when referring to legislation.
- **Clue 3:** Unusual phrasing or language, but you can't quite put your finger on what you would say instead: *"Approval shall not be untimely withheld."*

Write your answer here:

The correct answer is: a European country with a Civil Code. In this case, the contract was governed by Polish law, which has a concept of "due diligence". Other European countries (such as Germany) may have statutory requirements of "good faith".

The unusual wording may be because the contract was drafted by someone whose first language is not English, or it has been translated from another language.

Changing the governing law

Governing law should be considered at the start of the contract process; ideally before putting pen to paper, as it will determine how it is drafted, and who is best placed to draft it. Often, parties select it based on where the parties are located, the capabilities of in-house lawyers, consistency with other contracts, or what they are most comfortable with based on previous experience.

But what if the parties don't agree? My client asked me to review a contract with a new developer in Lithuania. The supplier sent its standard terms, which were governed by the laws of Lithuania. Having read what I've said so far in this article, you may well say to me that Lithuanian law should remain, as the terms had been drafted with that in mind. But it was better commercially for my client for the contract to be governed by English law. So one of the early points of negotiation was to change the governing law, recognising the need to amend the terms to reflect differences in contract law and practice.

Slipping in a new governing law as a last-minute change may be more precarious. I recently spent a couple of weeks drafting an agreement for a company, and it now seemed ready for signature. I received an email with a new version with one tiny amendment: the "laws of England and Wales" had been changed to the "laws of Norway" in the governing law clause. Such a small tweak could change the entire interpretation of the agreement. The options at that stage were: take the risk on interpretation, seek advice from a Norwegian lawyer (and delay signature), or change it back to England and Wales.

ABOVE A trip to Paris is never wasted, even if my legal services aren't required

"Slipping in a new governing law as a last-minute change may be precarious"

BELOW If no governing law is specified, there are rules for working out which law applies

Contracts or wine

If a contract is governed by laws other than England and Wales, it doesn't necessarily mean that us English-and-Welsh-law-qualified lawyers become useless. We can still advise on English law issues connected with the contract (such as data protection, intellectual property and consumer rights), and may give insights on other legal and practical implications of the terms. But there are limitations to our review, including potential differences in the effect of the provisions between the governing law and English law.

By complete coincidence, I received a request this week to review a contract governed by the laws of Ontario, Canada. Sadly, I was not the right lawyer to carry out the review, but I knew just what to do; I cracked open a bottle of French wine and settled down for a drink.

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DAVEY WINDER

“It appears almost comical, but that would be to underplay the seriousness of the risks”

Davey ponders the problems that occur when a secure sign-in for third-party services turns out to be not so secure after all

Imagine you used to work for a startup that went bust. You were always 100% mindful of your security when logging into third-party accounts at work, but you now find your sensitive data has been compromised. There are lots of reasons that this could happen – adversary-in-the-middle attacks and malware, to name a couple – although why they would strike now when the startup is no more, and you have moved on to pastures new, is a mystery.

Now imagine that a security vulnerability in the very process you were using to authorise yourself, supposedly securely, to those accounts was to blame. Welcome to the Sign-in with Google OAuth authentication flow issue that could have very real-world implications.

Like all hypotheticals grounded in reality, stay with me, as it’s not the pain meds talking; this is a rather complicated affair. At times it appears almost comical, but that would be to underplay the seriousness of the potential risks involved here.

Why do I say comical? Well, according to Dylan Ayrey, the CEO and co-founder of Truffle Security, the company that discovered the vulnerability, the researchers were awarded a bug bounty of, wait for it, $1,337. Google isn’t renowned for possessing a side-splitting sense of humour, but I’ll give it the benefit of the doubt and assume this was meant to be hacker funny (“leet”) rather than financially insulting.

As for underplaying the risks, well, this flaw could potentially open the doors of insecurity to access former employee accounts such as ChatGPT, Notion, Slack and Zoom, which was exactly what happened during the research. More serious than that?

Davey is a journalist and consultant specialising in privacy and security issues
𝕏 @happygeek

How about that the most sensitive accounts, according to Ayrey, included HR systems containing tax documents, pay stubs, insurance information and social security numbers? Then there were the job interview platforms with all the candidate feedback and financial offers made, and chat accounts with sensitive direct message content.

Ayrey said that the problem here sits with how Google’s OAuth login protects, or rather doesn’t protect, against an attacker purchasing a defunct domain and then using that to re-create email accounts for former employees. You might think we’re back in the world of hypotheticals again, but attackers come in many flavours and with many motivations – they’re more than capable of finding such defunct domains and lists of employees if there’s a profit to be made (whether financially or in terms of the information that can be accessed). While that attacker wouldn’t be able to access old email data, Ayrey found, they could use those accounts to log in to multiple software-as-a-service products that were being used by the organisation before it went belly up.

You are OAuthul

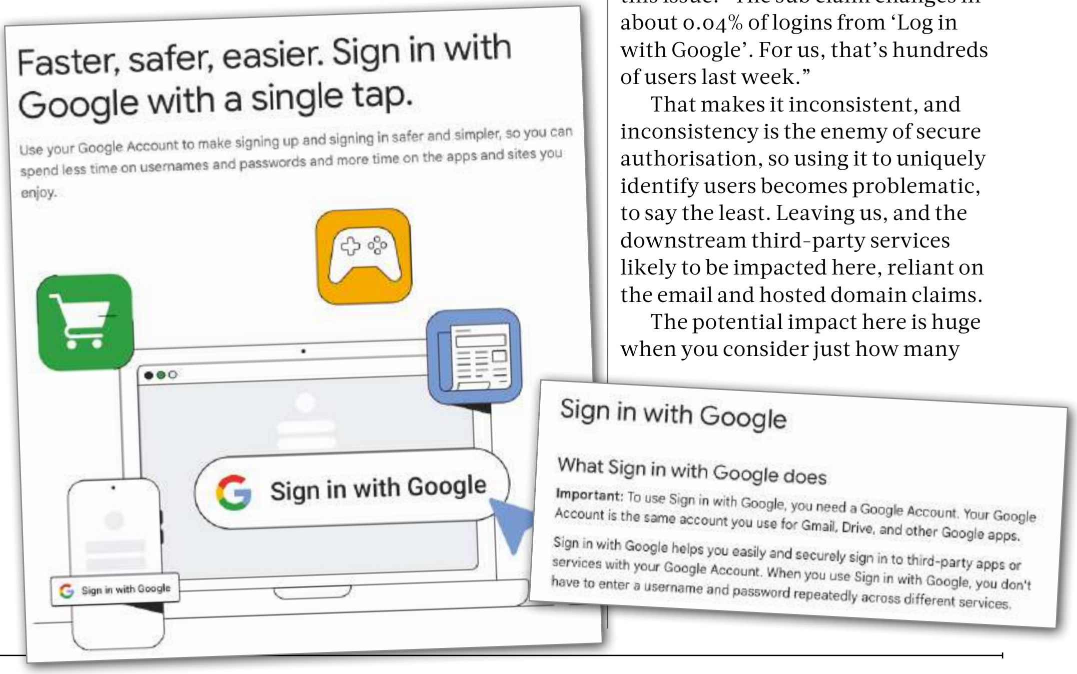
In his technical report detailing the security issue (**tinyurl.com/367OAuth**), Ayrey points the blame firmly at the way that domain ownership and OAuth interact. This was explained thusly, if you’ll allow me to paraphrase for simplicity.

When you hit the “Sign in with Google” button to securely authorise yourself to a third-party service, this sets off a series of “claims” about you, including specifying your hosted domain (someone at this domain is able to access the service) and your email address (someone with this address can access a specific account). These are then used to determine if you should be able to log in. You’ve probably guessed where this is going. If that service relies only upon these two claims then, assuming a change of ownership of the hosted domain, that domain will look the same to the service. “When someone buys the domain of a defunct company,” Ayrey said, “they inherit the same claims, granting them access to old employee accounts.”

Aha, I hear you cry, what about the SubID? How very knowledgeable you are, because yes, this is the unique identifier that’s assigned to “sub-partners” or affiliates within such an ecosystem. Ayrey admits that the SubID “could theoretically prevent this issue,” but insisted that, in practice, “it’s unreliable”. Here’s a direct quote from an unnamed staff engineer at one of the tech companies Ayrey worked with when exploring this issue: “The sub claim changes in about 0.04% of logins from ‘Log in with Google’. For us, that’s hundreds of users last week.”

That makes it inconsistent, and inconsistency is the enemy of secure authorisation, so using it to uniquely identify users becomes problematic, to say the least. Leaving us, and the downstream third-party services likely to be impacted here, reliant on the email and hosted domain claims.

The potential impact here is huge when you consider just how many



Faster, safer, easier. Sign in with Google with a single tap.

Use your Google Account to make signing up and signing in safer and simpler, so you can spend less time on usernames and passwords and more time on the apps and sites you enjoy.

Sign in with Google

What Sign in with Google does

Important: To use Sign in with Google, you need a Google Account. Your Google Account is the same account you use for Gmail, Drive, and other Google apps.

Sign in with Google helps you easily and securely sign in to third-party apps or services with your Google Account. When you use Sign in with Google, you don’t have to enter a username and password repeatedly across different services.

BELOW **The “Sign in with Google” button isn’t as secure as you might think**

startups fail – and I'm not even going to say what percentage, because that's not what matters here. What matters is that Ayrey used a startup database and found more than 100,000 domains available for purchase from those that had closed down. In one database, with one search. Ayrey also said that he estimates some 50% of tech startups use Google Workspace for their email, which further highlights the scale of the problem.

"If each failed startup averaged ten employees over their lifetime and used ten different SaaS services," he said, "we're talking about accessing sensitive data from more than ten million accounts."

Google's take

So, how can we fix this, aside from stopping the use of signing in with Google to authorise access to downstream third-party accounts? I spoke to my contacts inside Google to see what they had to say about the matter and, as it turned out, it was quite a lot.

Let's start with the official statement: "We appreciate Dylan Ayrey's help identifying the risks stemming from customers forgetting to delete third-party SaaS services as part of turning down their operation," said a Google spokesperson. "As a best practice, we recommend customers properly close out domains following these instructions [head to **tinyurl.com/367google**] to make this type of issue impossible. Additionally, we encourage third-party apps to follow best-practices by using the unique account identifiers (sub) to mitigate this risk."

Things get a little more complicated when it comes to the timeline of events and the response that Ayrey said he received from Google when reporting the issue to begin with. That timeline, as far as I can tell, looks like this:

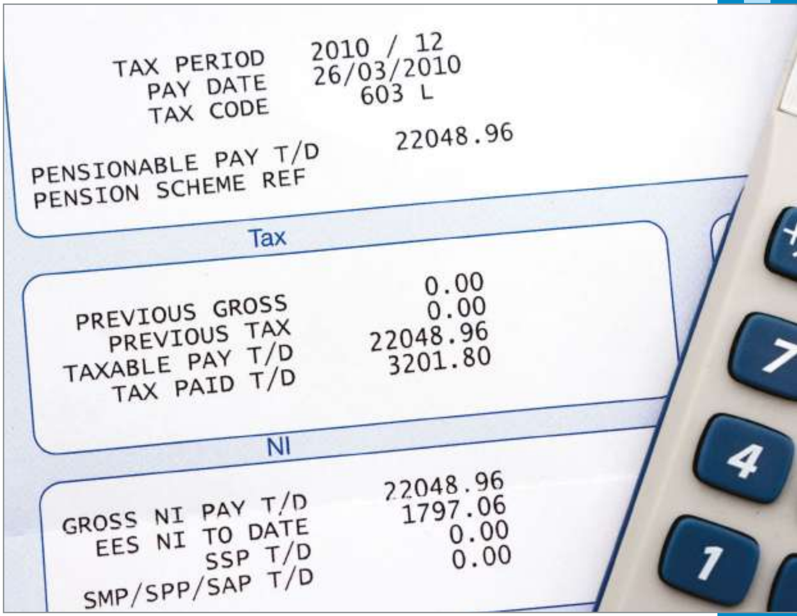
- Reported to Google – 30 September 2024
- Google marks as won't fix – 2 October 2024
- Shmoocon talk accepted – 9 December 2024
- Google re-opens issue – 19 December 2024

In a conversation with a Google spokesperson, I was told that, to be clear in the matter, it was determined that a fix wasn't necessary because a "strong and appropriate protection is already in place". That protection? Yep, the SubID field. Google told me that the sub field is the immutable identifier that the researcher is calling for as mitigation, and it strongly urged all developers to use it to provide extra protection. "We'll happily examine any materials on this," the spokesperson said, "but we've seen no evidence to support the assertion that the sub field is not an immutable and unique identifier."

Ayrey, meanwhile, insists that to fix the problem Google could implement two immutable identifiers within its OpenID Connect (OIDC) claims, namely a unique user ID that doesn't change over time and a unique workspace ID tied to the domain.

Back to Google, which told me that it had updated the documentation for developers (**tinyurl.com/367openID**) to make its guidance even more prominent.

Finally, the Google spokesperson said that the attack scenario identified doesn't pose a risk to data stored by Google itself, but rather to data stored on third-party platforms. And these third-party Google partners "have levers in place to protect against this type of issue". Such levers include, first, the deletion of all customer data when an account is closed to ensure company-wide accessible data is no longer available; second, the use of that sub field, again, as the unique-identifier key for the user to ensure user-specific data can never be accessed by any other entity. "This field is unique among all Google accounts and never reused," the spokesperson said.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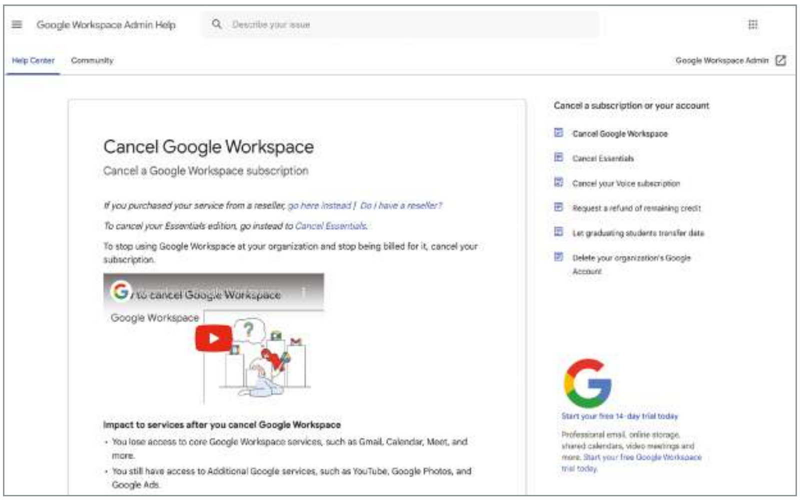
ABOVE The affected accounts included pay stubs and social security numbers

"The potential impact here is huge when you consider just how many startups fail"



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LEFT Around 50% of tech startups use Google Workspace for their email

What can companies do?

My issue, and it should be yours as well, is that as an individual employee, once you've been offboarded from an organisation you can't protect your data in those connected accounts as you no longer have any access to them.

I reached out to Baber Amin from identity vulnerability and security platform Anetac, who had some good ideas when it comes to implementing best practices to enhance the OAuth information flow.

The primary one, which addresses my offboarding concern, is to integrate OAuth revocation into the process. Develop a clear offboarding checklist that includes token revocation as a formal step in the HR and IT offboarding process, in other words. "When deprovisioning an employee," Amin said, "ensure that all third-party OAuth authorisations associated with their account are terminated."

Amin also said organisations should regularly review and audit OAuth permissions. Access your data, verify the permissions granted, and revoke access for any apps that are no longer necessary. Additionally, limit permissions to the minimum required for each application to function

Continued from previous page

effectively. Enforce strict token validation. Ensure that your applications (and any third-party integrations) verify token signatures rather than relying solely on a domain name. Implement domain verification and SSO policies. Some providers allow domain ownership verification for SSO and domain-based claims. If you lose this verification (for example, if a domain is stolen), the provider can invalidate or remove the domain from your configuration to prevent unauthorised usage.

AWS ransomware attackers

Talking of worrying attacks, how about this AWS ransomware threat that's impossible to recover from without paying the ransom? Yes, I know that's the whole point of ransomware, but stick with me.

The Codefinger ransomware attack against Amazon Web Services S3 buckets was uncovered and dissected (**tinyurl.com/367codefinger**) by researchers at Halcyon's threat research and intelligence unit. What raises this one above the ransomware norm, and where that impossible-to-recover-from label arises, is the fact that it leverages AWS's own server-side encryption with customer-provided keys, SSE-C, to encrypt data. Because it integrates directly with AWS's secure encryption infrastructure, it makes recovery impossible. Threat mitigation, however, is not.

I mention this is as the attack flow requires the identification of publicly disclosed or previously compromised AWS keys. Protect your goddam keys is not just an overhyped mantra, it's an essential that everyone of a sound security mind should have tattooed on their forehead.

"AWS helps customers secure their cloud resources through a shared responsibility model. Any time AWS is aware of exposed keys, we notify the affected customers," an Amazon Web Services spokesperson said. "We also thoroughly investigate all reports of exposed keys and quickly take any necessary actions, such as applying quarantine policies to minimise risks for customers without disrupting their IT environment."

davey@happygeek.com

STEVE CASSIDY

"The rule seems to be that the better the image, the less you're told about its creator"

A misty-eyed Steve asks why, in this era of supposed personalisation, the services we all use make us feel depersonalised?

Steve is a consultant who specialises in networks, cloud, HR and upsetting the corporate apple cart

@stardotpro

I really miss Winamp. No, seriously: I realise it just played audio, and agree with those who consider the visualisation plugin as "software for potheads", but what I mourn are the skins. You could make Winamp look like anything at all. There were steampunk skins, *Star Trek* skins, skins for *Star Wars*, Barbie and *The Matrix* (of course!), even a *Forrest Gump* skin.

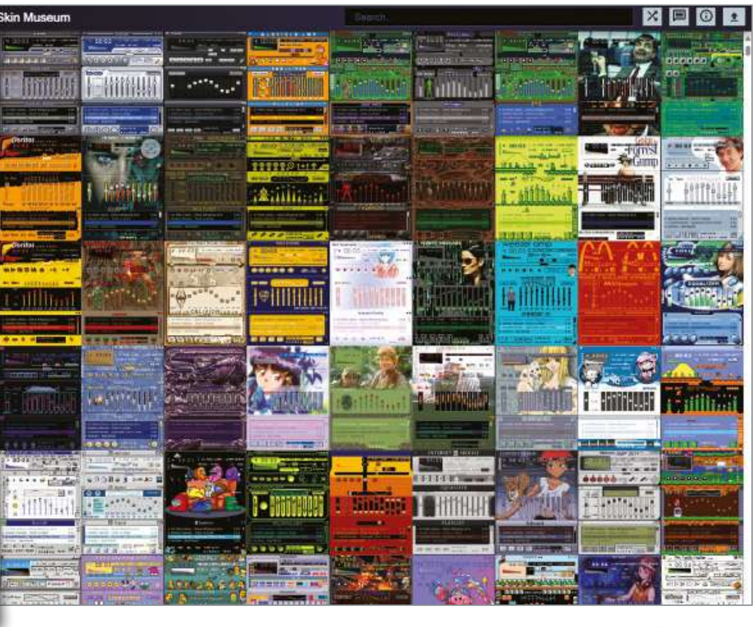
But simply reading that list will quicken the pulse of a copyright and trademark lawyer faster than a direct injection of four double espressos. The more popular the cultural event, be it a movie or a pop group, a child's toy or a soap opera, the more lawyers there will be chasing every potential breach of the copyright laws, looking for either a big out-of-court settlement or an even bigger fine.

The attraction of speculative lawsuits doesn't diminish when a "big brother" protector comes along and hands the inventors 80 million bucks, which is exactly what America Online did to Winamp in 1999. If anything, corporate owners' deep pockets will increase the attractiveness of the target for ambulance-chasers.

Which is a truly awful shame. Take a look at the Winamp Skin Museum (**skins.webamp.org**) and you'll soon realise that words such as "tapestry" don't do justice to this thoroughly modern gallery of unrestricted, grassroots creativity. Why? Because you could sit down and draw up a Winamp skin all your own, hardly any programming experience required. Send it to your mates, post it on your GeoCities homepage, upload it to a competition site: there was a whole ecosystem of hobby type things to do.

Winamp also provided a structure of plugins and services that allowed the humble home user to personalise their music streaming "experience" and the player software that presented it. Sure, there were cosmetic services for changing things such as button sizes, positions and labels, but there were also connectors to allow you to hook into other sources of audio than a straight MP3 file. This open approach fostered the expansion of a massive fan base of not just the software, nor the music, but also the hit movies and TV series of the time – which inevitably brought about the uncontrollable firestorm of copyright and trademark claims.

What troubles me is that these early and relatively harmless excursions by user-designers led to



BELOW **The Winamp Skin Museum is a modern gallery of grassroots creativity**

Microsoft
Windows xp

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ABOVE Smartwatch faces today are insipid compared to the garish customisations of old software

a nightmare scenario where naive fanboi types were fed into the combine harvester of "no win, no fee" predatory lawyers. Meantime, the owners of Winamp's intellectual property quietly shuffled away from the spotlight or blame, effectively saying, "not me, guv".

It would have been simple for Winamp developers to set up a little button and field in the player, crediting all found copyright holders with a Linktree-style scrolling list – but no, that type of plugin was anathematic to their approach, leaving Winamp's users open to the legal attentions of some of the biggest, meanest media corporations on the planet. How hard would it have been to have let the hobbyist skin-maker include a link to the movie website and instantly transform them from an evil burglar of trademarks into a lead generator?

I quite agree with those who look at the Winamp era as a time of some of the most appallingly garish and non-functional user interfaces ever presented. Even thinking about that period gives me a headache, remembering psychedelic Myspace home screens, AOL emails with a minimum of 150 exclamation marks and worse. But overall I would be prepared to put up with that wall of noise instead of the insipid galleries of smartwatch faces and phone screen backgrounds we're given at the moment.

Opaque artwork

Which brings me to my next, related subject: does no-one else find it strange that it's almost impossible to find out who made or designed your custom smartwatch templates? For example, I really like Microsoft's long-term commitment to supplying us with high-quality images, as expressed through Bing Desktop and its satellite apps, but the rule seems to be that the better the image, the less you're told about its creator.

That's forgivable for a wallpaper, but this lack of transparency also extends to modern customisation software. And that puts me right off the whole process.

The original premise of an app store was to provide a trustworthy space for your apps. And it did solve a problem, because the more traditional sources of utilities and the like had become inherently untrustworthy. How could anyone be expected to go through protracted processes of due diligence or supplier evaluation before checking out a free piece of photo effects software? Everyone wanted to be the guy with the cool application to show all their friends. Nobody wanted to be the bedroom geek with hundreds of man-hours spent watching the app and the network traffic it generated, even though that remains one of the best signs that you've picked a wrong 'un.

I remember a demo from French internet giant Alcatel, in which it triumphantly put a phone in a Faraday electrical signal suppression cage and showed it trying to have a conversation with an IP address in China. Every couple of minutes it would send out a lonely single packet. Even then you couldn't find an app that would give you a simple list of the addresses employed by your phone in, say, the preceding 48 hours. To make the demo work, Alcatel had bolted together what looked like a laboratory sandblasting cabinet crossed with an explosion in a duct tape factory, where it had laid power and data cabling to support the isolated router it had left inside the cage.

Whether you're an IT person with an easily roused, impatient client or manager, or a home computing aficionado with a back catalogue of pictures of your kids growing up, you should understand how difficult even the bigger players find it to set up protections and responses to unsafe apps. We all expect big enterprise-scale networks to have everything locked right down and every single device accounted for – such places do exist, but unfortunately so do the other kind.

Industry researchers will debunk your assumptions with just one or two revealing figures. For example, F-Secure of Finland said the average length-of-stay of an infection within a network later examined after a massive ransomware raid is 200 days. The normal response to such a number is incredulity, imagining that the victim forgot to switch on AV updates, but that misunderstands the problem.

> "What I really hate is that so many apps want such deep access to your phone"

App store

According to the hype when they first emerged, app stores justified their existence by their diligence in rejecting bad developers and bad apps alike. All downloads ought to have been tested for undisclosed behaviours, as part of the benefit the software repositories deliver to the user. The whole process has become, shall we say, legalistic. Instead of having clearly purposed and openly presented code, what we get are a few sullen warnings ("contains in-app purchases" is my most hated). But what I really hate is that so many apps want such deep access to your phone.

17:46
App permissions
Instagram
ALLOWED
Camera

BELOW Too many apps want access to your phone's camera, contacts and more

This has been drummed home to me because I was originally going to write about how Android has become the new home for re-skinning and other customisation services, but even a tiny dip into those waters gave me the chills. You'll see what I mean if you search for "launchers" or "customisation" in the Play Store. How quickly you move from the gentle lure of changing the way icons look to locking away everything on your phone behind a subscription app in the name of "speed and security".

The application I ran into was so pernicious that I'm not going to give you a link to follow or a name.

All of which means that you shouldn't just grab games for your toddler to play with on your tablet while you're stuck in WFH conference calls. Each download should be preceded by as many searches as you can think of, from reviews (another swamp of fakery that I'll leave for another day), through tech support resources to presences on forums. Anything that might help you build up a picture of the people you're letting inside your most personal computing devices.

My point then is this: given the adulteration of the app store idea and the proliferation of overly intrusive apps, we should fight back with our own set of demands. In particular, to have the right to customise the information we're shown about what our devices are doing.

Open up the console window on a Mac of almost any kind – Console, not Terminal – and you'll see an avalanche of status messages. For some reason these are imprisoned in that scrolling window, and in some log files somewhere deep in the parts of the file system you aren't encouraged to investigate. I want a little log-monitoring custom app that I can load up with trigger phrases, generating a nice flashing icon when a trigger is seen in the message flow. Is that really too much to ask?

We can buy dedicated machine information displays with funky live graphs, disk I/O stats and all that over a tiny USB lead with an accompanying app (check out the Annadue store on Amazon). But, it seems, only if you're a gamer and you've agreed what matters with all the other gamers first. I'd love to see those mini screens find a wider audience by letting the user define what appears on the screen, be it the number of emails per hour or the superconductor temperature of your quantum computer.

NETWORK
UL: 80.0 M
DL: 80.0 M
2021/2/1
23:58
84
4.8
41
46
83
RAM STATUS
GPU RAM
10934M
45
9900K
43
82649M

ABOVE This 5in mini screen costs £64 on Amazon and acts as a handy display – if you're a gamer

How would life be made any worse by a tiny burst of innovation here? I can't ask the app developer community, because they've made themselves unavailable for comment.

cassidy@well.com

What would you pay for a good camera?

If there's a more confused market than that for videoconferencing devices, I haven't seen or heard of it. A year ago Kensington showered me with little boxes containing USB-connected cameras, for plug-and-play, work-from-home activities – all on what I think of as businesslike, working-day applications.

By that I mean the hardware emphasises all-day high-resolution video. Most of these little boxes have stereo microphones, too, though they can be delivered by an innocuous aperture somewhere on the casing. These desktop cameras are only a couple of hundred quid at the most. The strange thing is that they are comprehensively out-performed by an average smartphone camera.

My video setup is a ruinous mess of tangled-up fossil devices I should have recycled years ago. I find a perverse appeal in the bizarre Logitech standalone device I literally found in the bin, pictured here: a fat column festooned with ports, lenses and speakers with a control app that lets you pan, tilt, zoom, mute and even call from a tablet or PC. Most of my amusement with this thing arises because I also have another fat columnar object in the JBL Bluetooth speaker, which makes for rather better audio both as mic and speakers than the Logitech log can achieve.

The thing is, why use special-purpose mid-range devices like these when even a cheap smartphone is good enough to keep a video call rolling? I was stuck in a PC-only rut for video calls because my collection of funny cams and bright yellow speakers was actually performing pretty well. It never occurred to me that my other collection, this time of 5G telephones, might be hiding a performance level way above my expectations.

Revelation came in an offhand remark while trying to make sense of a special City of London project run by EE. To participate I'd need an EE SIM, and the nice chap in the shop said, "of course, you do realise sir, no PAYG SIM will connect over a 5G signal". I was dumbfounded. What's the point of a restriction like that?

The good news is that there's no cause to worry when it comes to video calling on your smartphone over 4G. It's nice to have the potential of 5G for a later date but, right now, 4G combined with the high-speed processing that comes with a 5G-supporting chipset and CPU makes for a perfectly acceptable experience.

Except, possibly, for your callers. Most people are far more jumpy and animated when using their phones than they are with VC cameras, leading to the unexpected emergence of motion sickness as a by-product of working from home. Kensington had worked this one out when it sent over all its VC hardware catalogue: the biggest boxes contained great big heavy-steel articulated camera monopod arms, to hold absurdly small, light things such as USB cameras and lights in absolutely rigid positions.

LEFT This bizarre-looking Logitech device was rescued from the dustbin but it serves its purpose well

So back to my original question. You have consumer cameras down to the price of a burger'n'chips, phones going up to four-figure sums, the sprouting of mid-sized conferencing units from Logitech and Owl Labs that have won awards in this magazine, and then a big gap until you reach the heavy metal, boardroom-sized systems that can cost tens of thousands of pounds per part. One early estimate by Cisco said that the average corporate VC suite was priced at a quarter of a million bucks.

Being upstaged while presenting from a room like that by an office worker whipping out their £300 Nokia cannot be a comfortable feeling. This is why we like to keep an eye on the prices and performances of every part of the marketplace. And if that's the phone in your pocket, so be it.

Retro

Inspirational stories from computing's long-distant past

LEFT Many early shareware authors would ask users to send a floppy which they'd return with their programs

Computing's shareware revolution

At a time when the software industry was urging people to stop copying floppies, a small group of individuals actively encouraged it, giving birth to a new distribution model, explains **David Crookes**

There's little doubt that shareware revolutionised the way software was distributed in the early days of computing. It steamed in with a blend of innovation and accessibility, offering users a "try before you buy" model that went a long way towards democratising software development.

Suddenly, pioneering independent coders could reach a global audience without needing a big budget or corporate backing. They could create games and serious applications while breaking free from retail shelves, all the while shaping the digital landscape by offering consumers greater choice.

Key to this movement were a small number of individuals who took a great gamble with their work by pleading to the good side of human nature. Chief among them was former attorney, writer and publisher Andrew Fluegelman, who developed and released an excellent communications app called PC-Talk in 1982.

Instead of seeking a traditional publisher, he decided to send his app out for free and allow anyone to use, copy and distribute it. He hoped that users would engage with the software for a while and consider donating $25 if they continued to use and enjoy it. But get this. They didn't have to. PC-Talk would still work and offer a full feature set. And yet users still sent him money.

In an article published in *InfoWorld* in August 1982, Fluegelman revealed that, of all of the people he sent copies of PC-Talk to, around two-thirds decided to pay for it. He also reckoned that for every copy he sent out five copies were made by users, and this was something he encouraged because it got his software out there and increased the chance he'd make even more cash.

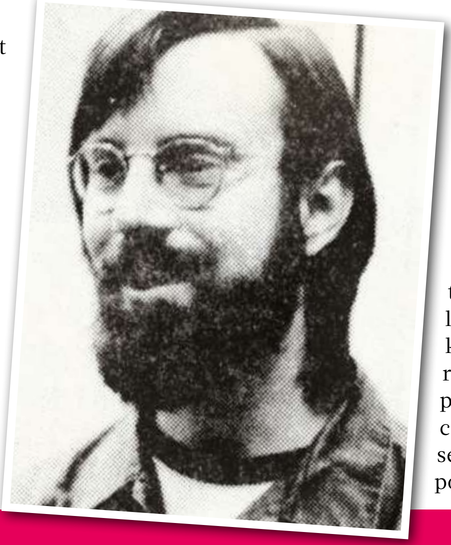
Indeed, whenever a user copied his software, it saved him a job. He was tapping into many a computer user's tendency to want to copy software, and they were distributing his program for free. He only needed to place a few ads in magazines or on the likes of CompuServe asking people to send a blank floppy disk to get the ball rolling. He didn't even need to properly package his software or create an expensive printed manual.

Little wonder, then, that Fluegelman ended up attracting a great amount of attention. Curiously, people seemed to want him to succeed and they would send notes with their cash expressing appreciation for his efforts. But Fluegelman was far from alone in having this idea or making this software model a success, and it would end up having a huge impact for many years to come.

Good to talk

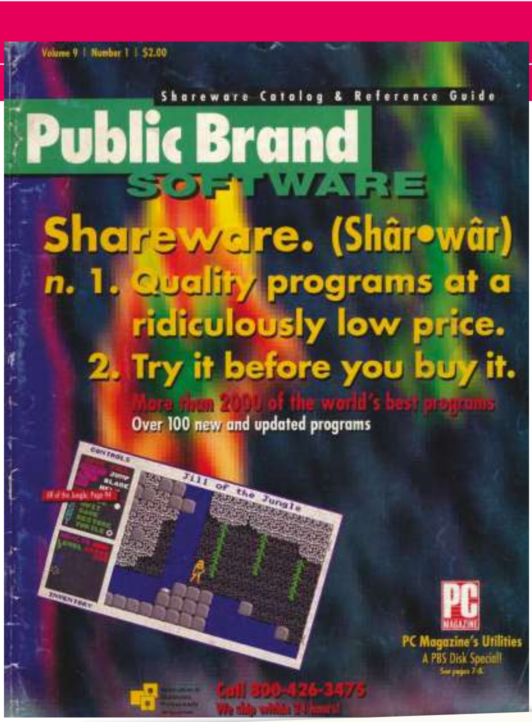
Around the same time, another programmer, Jim Knopf – who later went by the name of Jim Button – developed a flat-file database application called Easy File, originally to manage a church mailing list on an Apple II. The IBM employee later ported it to CP/M and DOS and passed it around his colleagues, but it went viral and ended up being far more widely copied outside of the company.

Shared online but predominantly on floppy disks by local user groups, the app became something of a passion project. Button worked on regular improvements and he encouraged people to add themselves to his mailing list so that he could let them know about the latest releases. This, however, proved painful: he simply couldn't afford to keep sending updates via the postal system.



BELOW Bob Wallace was one of the many pioneers who pushed the idea of shareware

Images: PublicDomainPictures, Pixabay, Wikimedia Commons, John Aurelius, member of the Northwest Computer Society, public domain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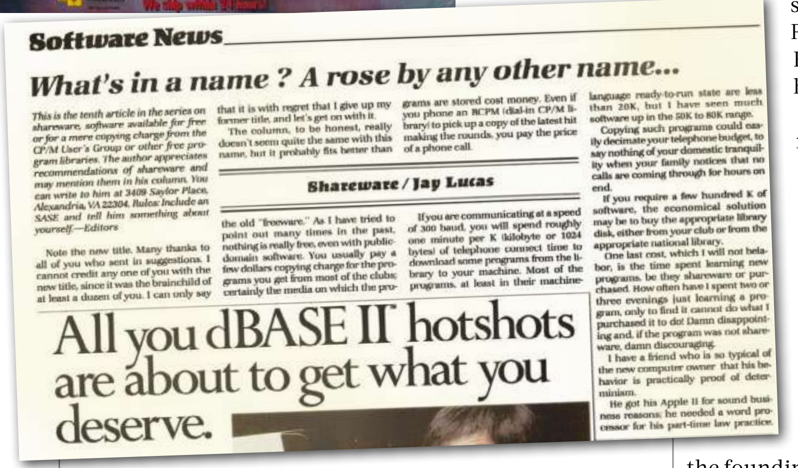
LEFT Shareware libraries had huge catalogues packed with titles

To ease the financial pressure, he added a note to Easy File in September 1982, the same month he set up Buttonware, requesting users donate $10 if they wanted to remain on the mailing list.

When one of those donors told Button that his software distribution model was very similar to that of Fluegelman's, Button got hold of PC-Talk and began reading the program's included documents. He learned that Fluegelman had set up an organisation called Freeware and was referring to PC-Talk as both "freeware" and "user supported software". Button also saw that Freeware wanted other programmers to join in and make their work available on a free, non-restricted basis, so he got in touch.

Following a telephone conversation, Button changed the name of Easy File to PC-File in line with PC-Talk, and he also raised the price to $25. But that increase didn't hold PC-File back and Buttonware soon became a full-time endeavour. It helped enormously that the apps were top quality and comparable to releases costing hundreds more. PC-Talk and PC-File were more than capable of holding their own against programs created by VisiCorp, Sorcim, IBM and dBASE makers Ashton-Tate.



Software News

What's in a name ? A rose by any other name...

This is the tenth article in the series on shareware, software available for free or for a mere copying charge from the CP/M User's Group or other free program libraries. The author appreciates recommendations of shareware and may mention them in his column. You can write to him at 3409 Saylor Place, Alexandria, VA 22304. Rules: Include an SASE and tell him something about yourself.—Editors

Shareware / Jay Lucas

Note the new title. Many thanks to all of you who sent in suggestions. I cannot credit any one of you with the new title, since it was the brainchild of at least a dozen of you. I can only say that it is with regret that I give up my former title, and let's get on with it.

The column, to be honest, really doesn't seem quite the same with this name, but it probably fits better than the old "freeware." As I have tried to point out many times in the past, nothing is really free, even with public-domain software. You usually pay a few dollars copying charge for the programs you get from most of the clubs; certainly the media on which the programs are stored cost money. Even if you phone an RCPM (dial-in CP/M library) to pick up a copy of the latest hit making the rounds, you pay the price of a phone call.

If you are communicating at a speed of 300 baud, you will spend roughly one minute per K (kilobyte or 1024 bytes) of telephone connect time to download some programs from the library to your machine. Most of the programs, at least in their machine-language ready-to-run state are less than 20K, but I have seen much software up in the 50K to 80K range.

Copying such programs could easily decimate your telephone budget, to say nothing of your domestic tranquility when your family notices that no calls are coming through for hours on end.

If you require a few hundred K of software, the economical solution may be to buy the appropriate library disk, either from your club or from the appropriate national library.

One last cost, which I will not belabor, is the time spent learning new programs, be they shareware or purchased. How often have I spent two or three evenings just learning a program, only to find it cannot do what I purchased it to do! Damn disappointing and, if the program was not shareware, damn discouraging.

I have a friend who is so typical of the new computer owner that his behavior is practically proof of determinism.

He got his Apple II for sound business reasons; he needed a word processor for his part-time law practice.

All you dBASE II hotshots are about to get what you deserve.

BELOW The column in *InfoWorld* that introduced the name "shareware"

What's in a name?

For a long while, such programs continued to be widely known as freeware, despite containing a request for money. But then in 1983, *InfoWorld*'s contributing editor Jay Lucas was told by Fluegelman that he couldn't continue to use the word as the heading for his column about such software.

Lucas asked readers for alternative suggestions and "shareware" came top by some margin. Lucas wasn't entirely happy at this enforced change. "The column, to be honest, really doesn't seem quite the same with this name," he lamented, but he stuck with it nonetheless, even though he still took "shareware" to mean any program being given away for free rather than just those asking for cash.

It helped that the apps were top quality and comparable to releases costing hundreds more

This changed shortly after. A former Microsoft employee, Bob Wallace, created a word processor called PC-Write and he decided to follow in the footsteps of Fluegelman and Button by adopting the same distribution model. He referred to PC-Write as shareware with Lucas' blessing, and the name became firmly established, especially for software that could potentially be paid for.

At the same time, Wallace introduced new shareware concepts as well. In the case of PC-Write, users would be asked to pay $75 and in return they'd get a printed manual, telephone support and source code access. They would also be handed a registration number, which they were told to enter into their copy of their program. This led to a revolution of its own.

If that user then copied PC-Write and handed it to someone else, the number would go with it. And if someone then tried to pay for a copy that had already been registered, they'd get a new number while the original registrant would receive $25, providing a great incentive to keep sharing.

All in all, this led to more than 45,000 registered users and it truly popularised the shareware business model, proving that people really would pay for something they could otherwise use for free and that, if incentivised sufficiently, they'd continue to pass it around to as many people as they could.

A flourishing model

Despite the huge success of his shareware model, Fluegelman pulled back. He began to concentrate his talents on editing *PC World* and *Macworld* magazines until he disappeared in 1985. Buttonware, however, continued releasing shareware such as PC-File+ and the games *Castaway* and *South American Trek*, while Wallace's Quicksoft also pushed ahead. Significantly, Button and Wallace became the founding chairpeople of the Association of Shareware Professionals in 1987.

By this time, more and more developers had gone down the shareware route and it was decided that a supportive group would be helpful. With shareware libraries growing in popularity, more and more users were gaining easy access to inexpensive software and huge catalogues were being built up.

Libraries would send out disks and operate online via a BBS. Later, they'd also distribute via CD-ROM, FTP and websites. But some shareware advocates believed a few of the libraries were charging too much (PC-SIG was the first to advertise shareware discs for sale). They also argued that users would be less likely to fork out an extra fee to the creators if they liked the software.

Many also felt a strand of shareware called crippleware was going against the spirit of the whole model by removing key features from programs, effectively forcing users who otherwise liked the software to donate.

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BELOW Software Labs was a major distributor of shareware in the early and mid 1990s

Originally, the idea was that people who couldn’t afford software wouldn’t have to pay, but increasingly this option was being taken away.

Despite that, the shareware concept was so popular it continued for the rest of the decade and into the early 1990s, with developers enjoying the closer relationship with users and the reduction of overheads. And while there was a lot of rubbish (and sadly, the risk of downloading a virus), some major software was being born from shareware.

Prime examples included McAfee’s first antivirus software, which was free to download in 1987, while the file archiving program PKZIP, created by Phil Katz, proved influential, having introduced the ZIP file format in 1989 (the shareware utility StuffIt on the Mac was just as important).

WinZip provided a graphical front end for PKZIP and went on to be a full product, while Trumpet Winsock was a great way of connecting to the internet in 1994. Winamp, meanwhile, made the switch from freeware to shareware. By avoiding going down the traditional route, developers and users were reaping the rewards.

Font of knowledge

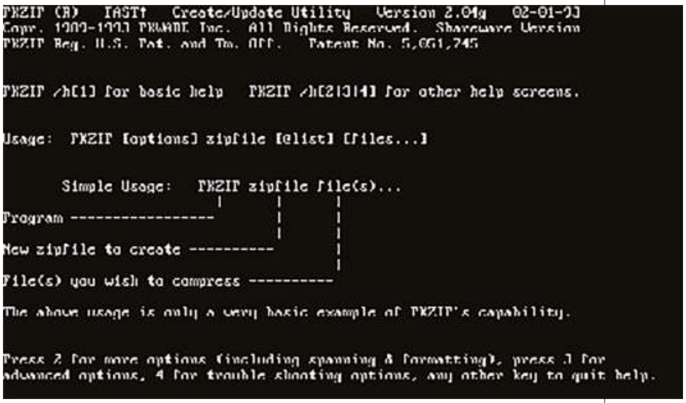
Gary Elfring was among those benefiting. He founded Elfring Soft Fonts as a way of distributing his typefaces and was acutely aware of the enthusiasm for the shareware scene. “I knew Bob Wallace and Jim Button and they weren’t any more revolutionary than anyone else in the group of software authors,” he said, pointing to the increasing depth of talent that was emerging.

Elfring had decided to go down the shareware route because he found adverts in PC magazines were too expensive. “I could send one disk to a shareware disk distributor either electronically or physically, or upload to their Bulletin Board System (BBS) and they would distribute the product for me. It was basically free advertising,” he told *PC Pro.*

Having designed PCL5 bitmapped soft fonts for HP laser printers back when there were few fonts and no speciality fonts available, Elfring said the shareware market proved perfect. He made his money from those who paid for additional sizes, styles and more fonts, with one font set selling almost a million copies in the 1980s.

The attraction, Elfring said, was clear. “The likes of Adobe were outrageously expensive and users had few choices at the time,” he continued. But as more and more developers came on board, Elfring, who was president of the Association of Shareware Professionals for a couple of years, also knew the sector had to move with the times.

By avoiding going down the traditional route, developers and users were reaping the rewards



```
PKZIP (R)    FAST!    Create/Update Utility    Version 2.04g    02-01-93
Copr. 1989-1993 PKWARE Inc.  All Rights Reserved.  Shareware Version
PKZIP Reg. U.S. Pat. and Tm. Off.    Patent No. 5,051,745

PKZIP /h[1] for basic help    PKZIP /h[2|3|4] for other help screens.

Usage:  PKZIP [options] zipfile [@list] [files...]

       Simple Usage:   PKZIP zipfile file(s)...
                            |       |       |
Program ---------------------       |       |
                                    |       |
New zipfile to create ---------------       |
                                            |
File(s) you wish to compress ----------------

The above usage is only a very basic example of PKZIP's capability.

Press 2 for more options (including spanning & formatting), press 3 for
advanced options, 4 for trouble shooting options, any other key to quit help.
```

ABOVE **It wasn’t much to look at, but PKZIP introduced the ZIP file format**

“We eventually relaxed the rules, allowing additional feature add-ons and other options to shareware packages,” he said. “Shareware was simply a way to advertise your software, and if you can’t get people to purchase from an advertisement, you alter the ad to get more purchases.”

Game on

The video-games sector played around with the shareware “rules” to some extent. Smaller developers and publishers were quick to see shareware as a great way to distribute games, and it led to titles such as *Scorched Earth*, *EGA Trek*, *ZZT* and *Duke Nukem* being downloaded – the shareware versions showed limited content and gamers would pay to unlock extra features.

But it was Scott Miller, founder of Apogee Software, who was truly groundbreaking. He came up with the idea of splitting a game into three episodes and giving the first one away as shareware. Players would pay to play the rest and the concept seemed to work well when it was used for the first time on the game *Kingdom of Kroz.*

This led Miller to approach id Software, which launched its first game *Commander Keen: Invasion of the Vorticons* in 1990 using the same model. “It was hugely successful so we kept doing it,” the developer’s co-founder John Romero told *PC Pro.* But it was the next game, the first-person shooter *Wolfenstein 3D*, that really made gamers sit up and take notice of shareware titles.

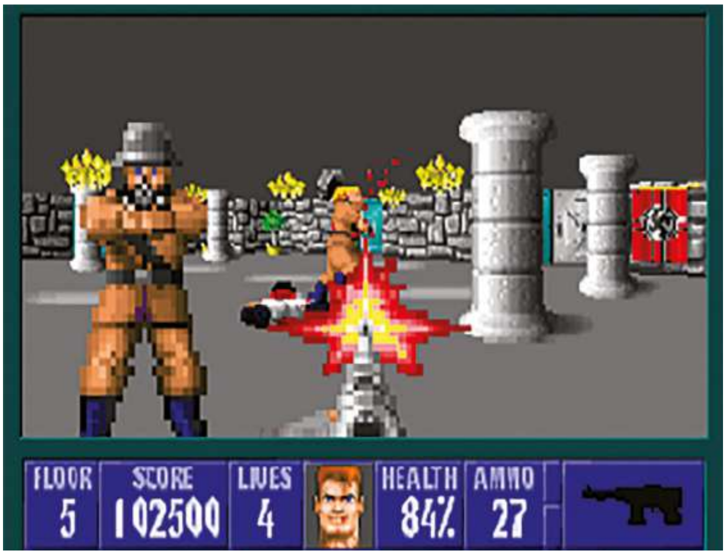
Wolfenstein 3D was of a quality that surpassed the majority of fully commercial releases, helping this shareware game sell more than 200,000 copies, and it was followed up by *Doom* and *Quake*, allowing id Software to continued a massively successful shareware run.

“Our profit margin was 50 per cent split with our publisher,” Romero said. “That was huge back then. It was also a really powerful business model – the beginning of today’s Free To Play model. If you liked the game, you paid and got the rest of it. Otherwise, you’d enjoy playing it, give copies away, and let others try it.”

Some experts say shareware peaked with *Wolfenstein 3D*, *Doom* and *Quake*, and there is some merit to that argument. Certainly, by 2000, shareware had largely fizzled out as a name. The idea that people needed to share software between themselves had long gone, too.

Even so, the fundamental concept has continued to some extent, with trials and “freemium” titles along with wider online distribution channels lowering the barriers of entry for many developers.

Users can also take advantage of free, open-source software, while social media has long been a great way to advertise. So while shareware made a big impact and changed the way many of us view software, its demise is not necessarily something to mourn. The spirit of shareware lives on, with more independent developers operating than ever before, and long may that continue. ●



BELOW ***Wolfenstein 3D* showed how effective the shareware model could be for games**

Images: Wikimedia Commons, archive.org

Futures

The trends and technologies that are the shape of things to come

Can liquid cooling help data centres avoid water wars?

Thanks to the AI boom, we need to build new data centres. But we also need better ways to cool them, says **Nicole Kobie**

As the hillsides surrounding LA burned, reports emerged of firefighters running out of water to douse the flames. In response, California lawmakers introduced bills designed to force data centres to publish how much water they use and work towards using less – but two weeks later, President Trump was promising to go big on data centres to power the AI boom, with $500 billion pledged to make it happen. The Labour government has promised something similar here in the UK, in the hope AI will boost the economy.

Can we build the next generation of data centres without dooming ourselves to water shortages, or even water wars? It's possible – and may even be technically necessary.

Data centres already use as much as 2% of global electricity, on a par with aviation, but it's predicted to climb to 4% within five years. About 40% of that power is used for cooling. And, as AI sparks demand for bigger, more complex data centres with cutting-edge chips, more energy and therefore more cooling is required.

Already, a small one-megawatt data centre using traditional air cooling slurps through as much as 26 million litres of water annually. Such big numbers are hard to comprehend, but in the city of The Dalles, Oregon, a legal fight between locals and Google revealed the latter's data centre used a quarter of the region's public water. And that's a problem when a fifth of data centres are located in water-stressed areas, according to research from the University of Tulsa.

The rise of AI is exacerbating an already growing problem. Research from the University of California Riverside and the University of Texas Arlington revealed that training OpenAI's GPT-3 consumed 185,000 gallons of water, while answering 20-50 questions requires about half a litre of water. Now imagine every search query running via AI.

"Big data centres... are hungry and thirsty," said Colm Shorten, senior director for data centres at JLL, a global consultancy and real estate firm.

But much of the focus on the environmental impact of data centres to date has been on energy use. Shorten says that's a serious but solvable problem – indeed, AI developers such as Google and Amazon are already investing in renewables and nuclear. Finding water where there is none is harder. "We can build power plants," he said. "It's very difficult to build a lake."

High costs of air cooling

The problem is cooling. Data centres can be cooled in myriad ways, but most use air-based cooling that evaporates or otherwise uses water to cool the air. For example, one common technique is evaporative cooling.

"We blow air through a heat exchange or a cooling coil, and we spray water on it to drop to temperature, we dissipate and we get evaporation," said Shorten.

Air cooling can be vastly cheaper than alternatives that use more energy, as water generally costs less than power. Plus, if the water is pulled in from public supplies, it's likely to be cold. "Sometimes it's much cheaper to use fresh

ABOVE **Immersive cooling can be used at either the chassis or the server level**

water because it has a very low temperature, so you don’t need to cool it down,” said Paul Konsbruck, CEO of LuxConnect, adding that by reducing energy use, this water-hungry technique can actually make a system appear sustainable.

But the US Department of Energy estimates evaporative cooling systems have a water usage effectiveness (WUE) of 1.8L per kWh, with a mid-sized data centre using as much as three to five million gallons a day, the same as a city of 50,000 people.

Ozgur Duzgunoglu, design and engineering director for Telehouse Europe, tells a story echoed by other experts spoken to by *PC Pro*: originally, data centres were designed to be reliable and resilient, with little concern for energy costs or water use. Then energy prices and sustainability rules sparked efforts to drive down electricity bills, leading to measurements such as power usage effectiveness and technologies such as evaporative cooling, which is more energy efficient than other techniques, even if it does use more water.

Now, as water shortages bite – and AI drives up performance demands of data centres – more focus is on WUE. “Now, heretofore, even though we would have used evaporative and adiabatic, we typically didn’t measure or monitor water consumption – and if you don’t measure it, you can’t manage it,” said Shorten.

However, the US lacks regulations – beyond the states of Washington and California, notes LiquidStack’s director of strategy Angela Taylor – that have forced the issue in the EU, UK and Singapore. Simply put, air cooling is generally cheaper – but it might not be enough for much longer. “With high-density workloads, like AI, air can no longer cool the IT equipment, and a change to liquid cooling is now under way,” she said.

Liquid future

The alternative is liquid cooling, which are closed systems – meaning the water that is used is kept in pipes and doesn’t evaporate away. It’s hardly a new technique. “We have been using liquid cooling for many decades going back to the mainframes in the 70s from IBM,” said Scott Tease, general manager for the product line at Lenovo ISG. “The technology is proven and super reliable.”

A one-megawatt data centre slurps through as much as 26 million litres of water annually

For modern data centres, one example is rear door heat exchangers (RDX). “In simple terms, we’re strapping a fridge to the back of the server, providing cold water in and a hot water return – it goes through what looks like a radiator or a fan. We use fans to blow that air, either the hot into the RDX or the cool air into the room, and that’s your air flow or your circulation,” JLL’s Shorten said.

ABOVE **LiquidStack cooling systems are entirely sealed**

By switching to a closed-loop system such as RDX, the amount of water being used at a data centre for cooling – ignoring hydroelectric power generating energy externally – is drastically reduced. “I always joke about this that actually the quantity of water that we use in our newest data centres is only depending on how much people go to the toilet every day, because that is the major use of water that we have in our data centre buildings,” said LuxConnect’s Konsbruck.

Another idea is direct-to-chip, in which a liquid coolant runs directly over chips. “You have a small metal plate on the top of the device with micro channels cut through it,” said Shorten. “You push in cool water, it catches the heat off the device itself, through the heat sink or the metal plate.”

Shorten points out that its technology specifically cools the GPU, so evaporative air cooling may still be used to reduce the temperature of the rest of the equipment in the room – storage and networking, for example – but the amount required is significantly reduced.

Then there’s immersive cooling, either at the chassis level or server level. “That’s when you pull a server out of a rack, open up the lid, and there’s fluid inside,” Shorten said. “Immersive is like a bathtub: you drop in all the servers, they’re completely immersed in the cooling liquid.”

LiquidStack’s Taylor explains that the fluid absorbs heat from the components, boiling it into vapour, removing the heat from the hardware. “The vapour rises, condenses on a cooling coil, and returns to its liquid form, creating a continuous, energy-efficient cooling cycle,” she said. “This closed-loop system eliminates the need for water or air cooling and offers superior thermal performance, especially for high-density workloads.”

Of course, there’s no need to choose any single option; Lenovo’s Tease says the company’s Neptune system offers direct cooling for entire systems, individual components, rear door techniques, and even liquid cooling for air-cooled systems. “These designs are geared toward meeting the demands of growing AI workloads,” Tease noted.

Technical demands

You may not be convinced that environmental concerns – or, put another way, the desire to be able to drink water in the future – will be enough to push the industry towards investing in a whole new way of cooling data centres. But the rise of AI may necessitate the shift.

The more energy a data centre uses, the more cooling is required – it's basic physics. And AI data centres are truly different from standard data centres, which currently operate at rack densities up to 10 kilowatts, though high-performance setups are pushing 30kW.

"Those types of densities, those types of transistors and those types of high-end devices, require a different type of technology," Shorten said of AI infrastructure. "You wouldn't be able to put them in a traditionally designed data centre. They would overheat, and we wouldn't have the power to deliver to those units, so you're building a different environment for them."

More intense computing means we need more intense cooling. Air cooling tops out at 20kW a rack, though it depends on the system. And AI is going to push densities ever higher. "Air is just completely inefficient, because you have to drive fan speed, you have to burn more electricity, let alone drink more water," Shorten said.

According to the Uptime Institute, a quarter of data centres already had rack densities above 20kw in 2022. "As those rack densities in chips become hotter, even if we had a jet engine to cool it and had a lake to throw water at it, [air cooling] wouldn't be sufficient," Shorten added. "We need closed loop and we need liquid cooling. So you're going to find a natural progression to liquid cooling or hybrid, either liquid to the chip, rear door heat exchanger, or immersive cooling."

Thankfully, those solutions are on the horizon – or already here. "Right now, the primary form of liquid cooling is single phase direct-to-chip," said LiquidStack's Taylor. "As chips continue getting hotter, I believe we will start to see a few other liquid-cooling technologies emerge. These include two-phase direct-to-chip and immersion. It's particularly exciting once we get to immersion as two-phase immersion can run with zero water, is very energy efficient, makes little noise, and can manage extremely dense up to 252kW in a single tank."

> "Our study with Eon shows that we can supply several thousand homes with free heating"

TOP Lenovo's Neptune offers direct cooling for server processors

ABOVE Two-phase liquid-cooling includes direct-to-chip and immersion

Challenges ahead

So if we have solutions, what's with all the headlines about data centres drinking up public water reservoirs? "The vast majority of data centres in the world are designed for air cooling – liquid cooling is far more efficient, but it is a change for many users," said Lenovo's Tease. "Many lack understanding of liquid cooling's benefits, but it will continue to become mainstream as power costs continue to rise alongside the increasing power consumption of the IT itself."

Beyond getting the word out, technical challenges remain. Immersion techniques show promise, but there are challenges that aren't yet fully unpicked. What liquid should be used? And what happens to it when we stick electronics in – do we risk creating air-bound particles that wreak havoc, the way CFCs in fridge coolant ate through the ozone layer? And how will being immersed in liquid impact chips? Nvidia hasn't yet approved immersion cooling for its GPUs, so it will void the warranty, notes Shorten, though that will surely change as the technology matures.

In short, more R&D is necessary to get these techniques ready for the AI boom, but we'll need to work quickly. Shorten predicts immersion will be ready within a few years, but regardless of timing, it's where the industry is headed. "It's definitely the direction of travel: from air cooling, to rear door heat exchanger, liquid to chip, and immersive cooling," said Shorten.

Location, location, location

The importance of water in a data centre depends on location. If you're building a data centre in California to be used for AI, you'll need to consider liquid cooling. But if it's for enterprise cloud or social media in a northern country with no water challenges, perhaps evaporative techniques can still find utility in order to cut energy use.

After all, if you want to cool a room in Northern Europe, just open the window – that's what Telehouse is doing in London, notes Duzgunoglu. "We can get free cooling for nine months of the year just by using external weather," he said, though of course it's a bit more complicated than that.

By running a closed system that is cooled using external temperatures, the environmental impact is minimal, Duzgunoglu claims. But data centre builders, operators and their clients could win over communities – and help avoid backlash from local residents – by building better systems that offer something back. Why just let heat dissipate when it could be put to use?

For example, closed systems lead to warm liquid that needs to be sent off to be cooled: why not make use of it? Telehouse is working with energy company Eon and local government to feed hot water into a central heating system for a new high-rise development. A heat exchanger will link up the data centre and the district heating system, providing free underfloor heating. "Our study with Eon shows that we can supply several thousand homes with free heating," Duzgunoglu said. Similar ideas are being considered by Octopus Energy for swimming pools.

We're going to build a lot more data centres; whether AI proves itself worthy of such efforts is a question that remains to be answered. But we have the technologies now to design systems that don't drink all our clean water, and might even give something back to local residents – we just have to take the time to make use of them. ●

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ON SALE
Thursday 3 April 2025

Features

Tweak Windows to meet your needs

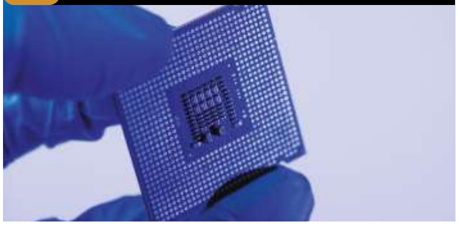
We're stuck with Windows 11 for a while, so make it work exactly like you want it to. We show you how using the best free and paid-for add-ons.

Features

Understanding reasoning LLMs

If you want to know how GPT-4 and other LLMs work, read next month's magazine. Not only will we pierce the hype, but we'll help you make sense of it all without using ChatGPT.

Features



What you need to know about CPUs

Whether AMD, Intel or Qualcomm, it's becoming increasingly hard to navigate the mess of chips, code names and capabilities. We're here to help.

Labs

Creative AI services

How well does Midjourney really compare to the best of its rivals, whether that's Adobe Firefly, Google's ImageFX, DALLE, Microsoft Designer or Stable Diffusion? We put them through a series of proper tests to find out.

Retro

Saving the history of videogames

David Crookes delves deep into the new digital library focused on game magazines, where you can remotely browse and access the Video Game History Foundation's entire collection of games.

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Please note: Labs and features are subject to change

Jon Honeyball takes a trip down optical memory lane

The news that Sony is finally shutting down production of its optical disc manufacturing facilities comes as little surprise. In the Big Book of World History, there will be an entire chapter on the rise and fall of optical media.

I still remember the thrill of CD audio's launch in the 1980s. "Pure, perfect sound forever" was the claim, and it failed on almost every front. The early discs sounded horrible, caused by a combination of the recording industry's ignorance of how to make the most of the format and early players of somewhat dodgy quality.

However, things improved rapidly as we wrapped our heads around new technologies such as oversampling, eight-to-fourteen modulation and Reed-Solomon encoding. These three items almost certainly mean nothing to you, so there's enjoyable reading to be done if you want to see just how clever the CD format was at the time.

For computer use, allow me to reminisce about my first CD drive. Made by Creative Labs, it shipped with an accompanying ISA sound card to slot into my desktop computer; 650MB of data seemed an awful lot back then.

Then came the first writable discs. I had already tried magneto-optical drives, which saw the mainstream light of day in the NeXTcube. They were slow and clunky, but their archiving capabilities were excellent. Now CD-R let us write our own data discs at home, even copy music, for a cost that wasn't silly. The first iterations were flaky, but it got there in the end. There are still worries about the longevity of the media, but as a solution for short-to-medium term storage, CD-Rs were excellent.

Next came the DVD, all 4.7GB of it. Then multiple layer discs and drives that upped the storage even further. Rewritable discs appeared soon after, and then Blu-ray arrived.

On the tape side, attempts to use DAT were usually relegated to the bin, with the technology earning the nickname of "Dies After Twoyears". This is in stark contrast to LTO, which has been a stalwart of machine rooms and data centres, offering huge storage and high speeds, although it usually comes with compatibility issues.

It's telling that LTO is the only tape storage technology that has survived, and its capabilities mean it will keep going into the future – albeit at a price that means it's for serious use only. A modern LTO drive costs five grand or more, and tapes aren't cheap, either.

So, should we mourn the passing of the optical formats? They were useful in their time, but our storage needs have moved on. You can still buy a rewritable DVD for under a pound, but think before writing valuable to it: you must trust that the discs will last and that you'll retain access to a working drive if you're considering it for long-term storage.

The problem is that solid-state storage has killed the market. A 1TB microSD card, smaller than your fingernail, costs under £100. I see there are even 2TB disks for double the money, which is an awful lot of storage for something so small. USB thumb drives are almost given away now.

One survivor from the old days might surprise non-photographers: CompactFlash. This has much higher storage ranges than SD cards. And for those who demand high performance, CFexpress and similar formats loved by the serious digital camera market not only offer gallons of storage but great performance, too.

So what are you going to do about long-term storage of your data? Most people I ask reward me with a blank look, so let me offer some advice: first, work out how much storage you need. Then consider buying a bunch of raw hard disks, another cockroach of the data storage world. Don't go cheap: I recommend spending a few hundred pounds on IronWolf Pro drives.

Buy several of them from different vendors, and a desktop mounting carrier into which you can drop the drive, and copy your data to it. Put the drive into a water-tight case, such as a Peli, and store it in your garage or loft. Take the drives out every couple of months and check the contents. When one dies, the other one will hopefully still be working.

Meanwhile, in the entertainment space, let's not forget there's an almost unbelievable quantity of CD and DVD/BD material on the second-hand market. Having the physical media means you can listen or watch it whenever you like, and there won't be an online streaming subscription draining your wallet every month.

> "Should we mourn the passing of the optical formats? They were useful in their time, but our storage needs have moved on"

There's just one caveat. CD and BD/DVD drives don't last forever, so your player might not last as long as the media. However, every CD should work in every CD drive, and the same goes for the video formats. And, as a by the way, I see that an external USB CD/DVD drive currently costs around £20.

Maybe it's time to explore the wonders of the boot sale, charity shop, and friends and family who want to clear their shelves?

Jon Honeyball is a contributing editor to *PC Pro* who still marvels at eight-to-fourteen modulation – look it up at tinyurl.com/367modulation. Email jon@jonhoneyball.com.

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